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STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.11 NAVIGATION		For general G&C operating data, refer to operating notes, 4.6.1.
		4.11.1 ORBITAL NAVIGATION		
		<u>4.11.1.1 (P21) Ground Track Determination</u>		Provides crew ground track data for either CSM or LM, based on time loaded in 3.
		CMC - on (req), 4.8.1.3		
CMP	1	Key V37E 21E	2,140	
	2	FL V04 N06 Option code 00002 CMC assumed option 0000X (00001 = CSM, 00002 = LM) Accept PRO Reject V22E (load desired option)		
	3	FL V06 N34		Initial display will contain zeros (present time). If not changed by astronaut, P21 calculations will be based on present time.
		GET lat long 00XXX. HRS 000XX. MIN 0XX.XX SEC		GET at desired position of selected vehicle.
		Accept PRO Reject V25E (load desired T-lat long)		

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	4	FL V06 N43		2,140	
		Lat (+N)	XXX.XX DEG		Selected vehicle latitude at T-lat long.
		Long (+E)	XXX.XX DEG		Selected vehicle longitude at T-lat long.
		Alt	XXXX.X NM		Selected vehicle altitude above launch pad radius for earth orbit, or above lunar radius at most recently defined landing site for lunar orbit, at T-lat long.
		If desired			
		Key N73			
		Alt/10	XXXXX. NM		Provides altitude display with scale compatible with altitudes associated with lunar mission.
		VI	XXXXX. FPS		
		Gamma	XXX.XX DEG		
		To increment T-lat long by 10 min			
		Key V32E			For V32E, program keeps previous state vector for use in starting next iteration without, however, ensuring that subsequent integrations are precision. If times reasonably close, V32E should be used; if far apart, would be quicker to reselect P21.
		Return to 3			
	5	PRO (term P21)			
		FL V37			
		Key XXE			R00.

(P21) GROUND TRACK DETERMINATION

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.11.1.2	(P22) Orbital Navigation		Purpose: • Locate, track and mark on lmk suitable for navigation. • Calculate orbital parameter changes generated by lmk sightings marks. • Display orbital parameter changes generated by first lmk sighting mark for crew/MSFN verification prior to state vector update. • Update known lmk coordinates. • Provide unknown lmk coordinates. • Track a preloaded landing site. • Provide coordinates of a new landing site (treated as an unknown lmk). • Provide coordinates of an offset landing site. • Point optics along an advanced orbit ground track to track and map a new landing site. Lmks may be known or unknown. Known lmk - Made known to CMC by Lat, Long/2 and Alt.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
				Unknown lmk - Identified to CMC as unknown lmk. There are two types of landing site mapping: • Landing site determination - Track and mark an unknown lmk and store coordinates in lmk ID 01. • Landing site offset - To store offset landing site coordinates in lmk ID 01. Only legitimate values of lmk ID in N70 and N71 are: 00 - known lmk loaded by N89 01 - landing site 50-57 advanced orbit option where units digit is the number of orbits ahead. (N70 only) Ground Track Determination Program (P21) available to aid in selection of lmks. For orbital navigation, W-matrix should not be initialized to magnitudes >328 fps and 51,647 ft (N99 display).
CMP		CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 Opt Pwr Up (req), 4.8.1.4 OPT ZERO - OFF OPT MODE - CMC SCS - on (req), 4.8.4.2	122	Provides monitoring and alternate control capability.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	1	Sel Tot Att Disp, 4.7.2.5		
	2	Sel Att Cont mode, 4.7.1		
CMP	3	Key V37E 22E	2,140	
		Poss PROG alarm (4.8.1.16)		R02.
	4	FL V06 N45 R3 - max MGA if X-axis inplane XXX.XX DEG		MGA maximum possible middle gimbal angle if CSM X-axis held in orbital plane.
CDR		If IMU align satisfactory Perform ORDEAL Init, 4.8.4.8 Mnvr to sighting att & establish orb rate Sel FDAI disp & att cont mode desired, 4.7.1 & 4.7.2		Initial sighting attitude should position optics shaft axis inplane and ≈50° ahead of local vertical. This provides optics cone of view which extends ≈90° ahead of local vertical at beginning of sighting.
		RHC - position Xsc axis ≈20° above lcl horiz, SEF hds up; as lmk approaches, pitch slowly to ≈20° below horiz (put COAS LOS on horiz or use ORDEAL FDAI)		As lmk approaches, pitch CSM down ≈20° below horizon. Cone of view now extends from ≈50° ahead to ≈30° aft of local vertical.
		RHC or MIC - pitch to offset orb rate, roll to avoid shft axis ≈10° of lmk, if known		Sighting attitude should be adjusted by small roll maneuver, if necessary, to prevent optics shaft axis from passing within 10° of target lmk. The 10° separation of lmk LOS and shaft axis ensures optics drive rates are not exceeded because of optics shaft reversal to avoid trunnion stop at -5°.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		PRO (If E.O., go to 6)	2,140	
	or	If realign desired Key V37E XXE		Select IMU realignment procedure. Reselect P22 at completion of realignment procedure.
	5	FL V05 N70 (L.O. only) R2 - lmk code ABCDE A 1 (known lmk), 2 (unknown lmk) B Index of offset designator C Not used DE lmk ID		
		Reject Key V22E Load desired lmk code		
		Accept If A = 2 OPT MODE - MAN PRO Go to 8	 122 2,140	
		or If A = 1 & DE = 01 or 50-57 PRO Go to 7		PROG alarm (00404) may occur at this point.
		or If A = 1 & DE = 00 PRO		
		Poss OPR ERR A = 0 or >2, B >5, or DE ≠ 00, 01 or 50-57 Recycle 5		

(P22) ORBITAL NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	6	FL V06 N89 (lmk data)	2,140	
		Lat (+N) XX.XXX DEG		Lmk latitude.
		Long/2 (+E) XX.XXX DEG		Lmk longitude divided by 2.
		Alt XXX.XX NM		Lmk altitude above Fischer ellipsoid for earth orbit, or above mean lunar radius for lunar orbit.
		Reject V25E		
		Load desired data		
		Accept PRO		
		Poss OPR ERR		
		R1 or R2 >90°		
		Recycle 6		
		(R52, Auto Optics Positioning Routine)		Points optics SLOS to selected lmk automatically. If in lunar orbit and a lmk code (DE) of 50 through 57 loaded in 5 (E defining desired number of orbits ahead), CMC points optics 60° ahead of CSM along advanced orbit.
		Poss FL V05 N09		PROG alarm light on.
		00404 (TA >90°)		
		Mnvr CSM until opt can acq lmk		
		PRO		PRO recomputes required optics angles.
		or V34E (term prog)		
		FL V37		R00.
		Key XXE		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		If TA >50° & <90°		If TA >50° and <90°, trunnion driven to upper limit (≈49.7754°) and held at this angle.
		Mnvr to reduce trun angle		Key V16 N92E for display of required optics angles if not presently displayed.
	7	V06 N92 (new OCDU angles) SA XXX.XX DEG TA XX.XXX DEG	2,140	No display if OPT MODE - MAN or if R52 reselected after R53 called, see next remark.
		To mrk, OPT MODE - MAN	122	Selects R53. To regain auto optics positioning, select OPT MODE - CMC (prior to completion of R53). CSM attitude rates ≥two-thirds degree/second will result in rejection of sighting marks; indicated by PROG alarm.
		(R53, Sighting Mark Routine)		
	8	FL V51 (please mrk)	2,140	
		Center lmk in opt	121	Known or unknown lmk in SCT. If mark made on an offset lmk (landing site), key V52E (after offset mark) or use N71 in 9 to identify offset mark. If only one mark made, it should not be identified as offset landing site. If more than one mark made, any mark may be used (and identified) as offset landing site mark. If desirable to terminate lmk tracking without making marks, key V34E or V37E XXE.
		MARK pb - push	122	
		Accept Repeat mrk proced		If more marks desired.
		or PRO	2,140	If sufficent marks made. At least one unrejected mark must be made before keying PRO. Otherwise, V51 reinstated. If desirable to terminate lmk tracking without making marks, key V34E or V37E XXE.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Reject MARK REJ pb - push Repeat mrk proced	122	
		If 5 mrks made FL V50 N25 00016 (term mrks)	2,140	
		Accept PRO Reject MARK REJ pb - push Repeat mrk proced	122	Rejects last (5th) mark.
		OPT ZERO - ZERO (≈15 sec to zero) OPT ZERO - OFF OPT MODE - CMC Exit R53 & R52		
	9	FL V05 N71 (lmk data) R2 - lmk code ABCDE	2,140	If mark was made on an offset landing site, ensure that B corresponds to mark. If no offset landing mark made, ensure B = 0.
		A 1 (known lmk), 2 (unknown lmk) B Index of offset designator C Not used DE Lmk ID		
		Reject V22E Load correct data in R2 Accept PRO If A is 2 (or A is 1 & DE = 01) Go to 11 Poss OPR ERR A = 0 or >2, B >5 or DE ≠ 00 or 01		

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	10	FL V06 N89 (lmk coord)		2,140	If auto optics positioning was performed, this data will be identical to N89 data loaded in 6.
		Lat (+N)	XX.XXX DEG		
		Long/2 (+E)	XX.XXX DEG		
		Alt	XXX.XX NM		
		Reject V25E (load desired data)			
		Accept PRO			
		Poss OPR ERR R1 or R2 >90° Recycle 10			
	11	FL V06 N49			
		ΔR	XXXX.X NM		Position vector change magnitude.
		ΔV	XXXX.X FPS		Velocity vector change magnitude.
		Accept PRO			
		Reject V32E			
		E.O. - return to 6			If in earth orbit.
		or L.O. - return to 5			If in lunar orbit.
	12	FL V06 N89			If offset landing site mark made and identified to CMC, display is offset landing site coordinates. Otherwise, display is coordinates of lmk on which marks were taken.
		Lat (+N)	XX.XXX DEG		
		Long/2 (+E)	XX.XXX DEG		
		Alt	XXX.XX NM		
		Accept PRO (L.O. only) Return to 5			Stores coordinates in CMC memory as landing site (lmk ID 01). Previously stored landing site coordinates erased.

(P22) ORBITAL NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Reject V32E E.O. - return to 6 or L.O. - return to 5	2,140	Does not store coordinates.
	13	Key V34E (to term P22) FL V37 Key XXE		V34E at any flashing display terminates P22. R00.
	14	Set opt cont OPT ZERO - ZERO OPT PWR - OFF RETCL BRT tw - DIM	 122 100 122	

4.11.1.2

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.11.1.3 (P23) Cislunar Midcourse Navigation		Accomplishes midcourse navigation by incorporating star/earth and star/moon optical measurements.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14		Permits auto maneuver to tracking attitude and auto optics positioning, if desired. Optics should be on for 15 minutes prior to marking.
		SCS - on (req), 4.8.4.2		Provides monitoring displays and alternate control capability.
		RCS DAP - Load & activate (desired), 4.8.2.1		Required if automatic attitude maneuver desired. For cislunar navigation, W-matrix should not be initialized to magnitudes >328 fps and 99,999 feet (N99 display).
		Opt pwr up (req), 4.8.1.4		
	1	Sel Tot Att Disp, 4.7.2.5		
	2	Sel Att Cont mode, 4.7.1		
CMP	3	Key V37E 23E	2,140	
		(R57, Optics Calibration)		Measures effect of solar radiation on SXT trunnion angle and stores measured trunnion bias for P23.
		If IMU orient unknown RHC - mnvr to acq star in SXT FOV		Select suitable star for use by Optics Calibration Routine, R57.
		Go to 8		
	or	IMU orient known Go to 4		

(P23) CISLUNAR MIDCOURSE NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	4	FL V50 N25 00015 (request auto mnvr, calib star)	2,140	
		Accept PRO Reject RHC - mnvr, acq star/lunar or earth disc in SXT FOV ENTR, go to 8		Select a suitable star/lunar or earth disc for use by Optics Calibration Routine, R57.
	5	FL V01 N70 Star ID (calib) 000DE Lmk code ABCDE Horiz ID 00CD0		Only R1 is of significance for R57.
		Reject Key V21E (load desired data) R1 - 00 for planet 01-45 for star Accept Rcd data PRO		
		Poss OPR ERR		Target code negative of >50.
		If 00 R1 51, go to 7		
	6	FL V06 N88 (planet only) X, Y, Z .XXXXX Accept PRO Reject Key V25E, load desired data		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R60, Attitude Maneuver Routine)		Provides for maneuver (auto or manual) to attitude calculated by vecpoint routine.
CMP	7	FL V50 N18 (CMC auto request)	2,140	
		R, P, Y XXX.XX DEG		Required gimbal angles.
CDR		Accept SC CONT - CMC	1	
		CMC MODE - AUTO		
CMP		PRO	2,140	
		V06 N18		Static display until completion of auto maneuver and then reverts to FL V50 N18.
		R, P, Y XXX.XX DEG		
		Mon auto mnvr on FDAI		
		Recycle 7		
		Reject V62E		Provides error needle reference for manual maneuver.
		RHC - null FDAI err needles		
		Recycle 7		
CDR		or SC CONT - SCS (or CMC MODE - ≠ AUTO)	1	
CMP		PRO (updates disp)	2,140	Recomputes desired attitude without performing auto maneuver.
		Recycle 7		
		or ENTR (exit R60)		When attitude satisfactory.
	8	FL V59 (perform calib mrk)		
		Accept Ctr desired calib feature or star in SXT		
		OPT ZERO - OFF	122	
		OPT SPEED - LO		
		OPT MODE - MAN		
		OPT TELTRUN - SLAVE TO SXT		
		OPT COUPLING - DIR		

(P23) CISLUNAR MIDCOURSE NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Superimpose SLOS & LLOS MARK pb - push Go to 9	122	Trunnion bias angle is a function of angle between LLOS and sun and is a constant if sun is outside cone ±15 deg from LLOS.
	Reject	If IMU orient unknown OPT MODE - MAN ENTR Go to 17 If IMU orient known OPT MODE - CMC ENTR Go to 10	 2,140 122 2,140	If optics were calibrated with sun outside cone defined in preceding remark and are used outside cone during future marks, recalibration not necessary. If sun is within cone, calibration should be performed each time through P23. PROG alarm (00404) may occur at this point.
	9	FL V06 N87 R2 - trun bias XX.XXX DEG		Scaling of N87 is such that small negative angle will appear as positive angle approaching 90°. (Actual angle equal to 90° minus displayed value.)
	Accept	If IMU orient unknown OPT MODE - CMC PRO, go to 17 If IMU orient is unknown PRO Go to 17	 122 2,140	 CMC stores calibration angle.
	Reject	If IMU orient known, return to 4 If IMU orient unknown, return to 8		
	10	FL V05 N70 Star ID 000DE Lmk code ABCDE Horiz ID 00CD0		
	Reject	Key V25E (load desired data)		Either R2 or R3 should be 00000, but not both.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	R1 - 00 for planet 01-45 for star R2 - AB not used C 1 (earth lmk), 2 (moon lmk) DE not used	2,140	R1 000DE Star or planet ID R2 00100 Star/EL 00200 Star/LL
	or R2 - 00000 for horiz measurement		
	R3 - horiz ID C 1 (earth horiz), 2 (moon horiz) D 1 (near horiz), 2 (far horiz)		R3 0010 Star/ENH 00120 Star/EFH 00210 Star/LNH 00220 Star/LFH
	or R3 - 00000 for lmk measurement		
	Accept Rcd data PRO go to 11		
	or If sighting on planet/horiz, go to 12		
	or If sighting on star/horiz, go to 13		
	Poss OPR ERR R1 <0 or >45		
	or R2 (C) & R3 (CD) = 0		
	or R2 (C) & R3 (CD) = 1 or 2 Either R2 or R3 must be zero (but not both)		

(P23) CISLUNAR MIDCOURSE NAVIGATION

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	or R2 (C) = 0 & R3 (C&D) ≠ 1 or 2	2,140	
	Recycle 10		
11	FL V06 N89 Lat (+N) XX.XXX DEG Long/2 (+E) XX.XXX DEG Alt XXX.XX NM		If planet or star and either earth or moon landmark sighting. Above Fischer ellipsoid for earth orbit, or above mean lunar radius for lunar orbit.
	Accept PRO If planet not specified, go to 13 Reject V25E (load desired data)		
	Poss OPR ERR R1 or R2 >90° Recycle 11		
12	FL V06 N88 (planet only) X, Y, Z .XXXXX		
	Accept PRO Reject V25E (load desired data)		
13	FL V50 N25 00202 (request 3-axis mnvr)		Optional 3-axis maneuver or vecpoint maneuver available.
	Accept PRO (3-axis mnvr), go to 14 Reject ENTR (vecpoint mnvr), go to 14		PRO or ENTR calls R60 to perform automatic maneuver.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R60, Attitude Maneuver Routine)		Provides for maneuver (auto or manual) to attitude calculated by 3-axis or vecpoint routines.
CMP	14	FL V50 N18 (CMC auto request)	2,140	
		R, P, Y XXX.XX DEG		Required gimbal angles.
CDR		Accept SC CONT - CMC	1	
		CMC MODE - AUTO		
CMP		PRO	2,140	
		V06 N18		Static display until completion of auto maneuver and then reverts to FL V50 N18.
		R, P, Y XXX.XX DEG		
		Mon auto mnvr on FDAI		
		Recycle 14		
		Reject V62E		Provides error needle reference for manual maneuver.
		RHC - null FDAI err needles		
		Recycle 14		
CDR		or SC CONT - SCS (or CMC MODE - ≠ AUTO)	1	
CMP		PRO (updates disp)	2,140	Recomputes desired attitude without performing auto maneuver.
		Recycle 14		
		or ENTR (exit R60)		When attitude satisfactory.
		(R52, Automatic Optics Positioning Routine)		Points SLOS of optics at selected star.
		Poss FL V05 N09		
		00404 (TA >90°)		
		Mnvr to reduce TA		
		PRO		
		or V34E		
		FL V37		ROO.
		Key XXE		

(P23) CISLUNAR MIDCOURSE NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If TA >50° and <90°		If TA >50° and <90°, trunnion driven to upper limit (≈49.7754°) and held at this angle.
CMP		Mnvr to reduce TA		
	15	V06 N92 (desired opt angles) SA XXX.XX DEG TA XX.XXX DEG	2,140	Optics will drive to acquire selected star or planet.
		(R53, Sighting Mark Routine)		
	16	OPT MODE - MAN	122	
	17	FL V51 (please mrk) 2,140 Check star & lmk are in SXT FOV OPT COUPLING - RSLV OPT SPEED - LO RHC - position lmk near ctr of SXT FOV OHC - superimpose star & lmk images MARK pb - push	2,140 122	If CMC aid in reacquiring lmk/horiz desired, key V94E and place OPT MODE switch to CMC. V94 terminates R52 and R53, starts R60 going again, recalculates required optics vector, reselects R52 and positions optics. V94 usable only in P23 from R52 callup through R53 to mark accept (PRO in 18).
	18	FL V50 N25 00016 (term mrks)	2,140	
		Accept PRO		
		Reject MARK REJ pb - push Return to 17	122	
	19	FL V05 N71 Star ID 000DE Lmk code ABCDE Horiz ID 00CD0	2,140	Refer to 10 for codes.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Reject V25E Load desired data Accept Rcd data PRO If sighting on planet/horiz Go to 21 If sighting on star/horiz Go to 22 Poss OPR ERR R1 <0 or >45 or R2 (C) & R3 (CD) = 0 or R2 (C) & R3 (CD) = 1 or 2 Either R2 or R3 must be zero (but not both) or R2 (C) = 0 & R3 (C&D) ≠ 1 or 2 Recycle 19	2,140	
	20	FL V06 N89 Lat XX.XXX DEG Long/2 XX.XXX DEG Alt XXX.XX NM Accept PRO If planet not specified, go to 22 Reject V25E Load desired data		Altitude above Fischer ellipsoid for earth orbit, or above mean lunar radius for lunar orbit.

(P23) CISLUNAR MIDCOURSE NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Poss OPR ERR R1 or R2 >90° Recycle 20	2,140	
	21	FL V06 N88 (planet only) X, Y, Z .XXXXX Accept PRO Reject V25E (load desired data)		
	22	FL V06 N49 ΔR XXXX.X NM ΔV XXXX.X FPS Accept PRO Reject Reselect V37E 23E, return to 3 or V32E (go to 23)		 Magnitude of position vector change. Magnitude of velocity vector change. Updates state vector. No state vector update if reject option selection.
	23	FL V37 Key XXE		
	24	Key V93E (if necessary)		If state vector update via P27 has not occurred. Enables W-matrix initialization.
	25	Set opt cont OPT ZERO - Zero OPT PWR - OFF RETCL BRT tw - DIM	 122 100 122	

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.11.1.4	(P24) Rate Aided Optics		• To locate and acquire lmk via auto optics positioning.
	CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2 RCS DAP - load & activate (req), 4.8.2.1 Opt pwr up (req), 4.8.1.4 Sel Tot Att disp, 4.7.2.5 Sel Att Cont mode, 4.7.1		• To track lmk using manual rate-aided optics feature of R52. • Obtain and downlink unlimited number of sighting marks of chosen lmk.
1	Key V37E 24E	140	
2	Mnvr to sighting att		Tracking may be facilitated by initiating pitch maneuver using V79 (PTC/orb rate) procedure.
3	FL V06 N89		
	Lat (+N) XX.XXX DEG		Lmk latitude.
	Long/2 (+E) XX.XXX DEG		Lmk longitude divided by 2.
	Alt XXX.XX NM		Lmk altitude above Fischer ellipsoid for earth orbit, or above mean lunar radius for lunar orbit.
	Reject V25E Load desired data Accept OPT MODE - CMC PRO		
	Poss OPR ERR R1 or R2 >90° Recycle 3		

(P24) RATE AIDED OPTICS

STA/T STEP	PROCEDURE	PANEL	REMARKS
	(R52, Auto Optics Positioning)		
CMP	Poss FL V05 N09 00404 (TA >90°)	140	PROG alarm light on.
	Mnv CSM until opt can acq lmk PRO		PRO recomputes required optics angles.
	or V34E (term prog) FL V37 Key XXE		R00.
	If TA >50° & <90°		If TA >50° and <90°, trunnion driven to upper limit (≈49.7754°) and held at this angle.
	Mnvr to reduce TA		Key V16 N92E for display of required optics angles if not presently displayed.
4	V06 N92 (new OCDU angles)		No display if OPT MODE - MAN or if R52 reselected after R53 called.
	SA XXX.XX DEG TA XX.XXX DEG		
	To mrk OPT MODE - MAN	122	Selects R53 and enables rate-aided drive feature of R52. To regain auto optics positioning, select OPT MODE - CMC (prior to completion of R53). Having regained auto optics, FL V51 remains; rate-aided drive is disabled. However, marking process may be continued.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R53, Sighting Mark)		
CMP	5	FL V51 (please mrk)	140	
		Ctr lmk in opt		Lmk is centered by using OHC augmented by rate-aided optics feature of R52.
		MARK pb - push	122	Stores mark data in downlink area.
		Accept Repeat mrk proced		Number of marks unlimited.
		Reject MARK REJ pb - push		Places complement of last mark's time register on downlink.
		Recycle 5		
		Poss OPR ERR 00110 (no mrks made)	140	
		To term mrks PRO		If sufficient marks made. At least one unrejected mark must be made before keying PRO. Otherwise, V51 reinstated. If desirable to terminate lmk tracking without making marks, key V34E or V37E XXE.
		FL V37 Key XXE		
	6	Set opt cont		
		OPT ZERO - ZERO	122	
		OPT PWR - OFF	100	
		RETCL BRT tw - DIM	122	

(P24) RATE AIDED OPTICS

STA/T	STEP	PROCEDURE		PANEL	REMARKS
		4.11.1.5 (V82) Orbit Parameter Display (R30)			Provides crew with CMC computed orbital parameters. Time from perigee/perilune (TF perigee) available via N32 if Hp >49.4 NM (300,000 ft) for earth orbit or >5.8 NM (35,000 ft) for lunar orbit. If P00 or P11 running, ΔR (miss distance) available via N50.
		CMC - on (req), 4.8.1.3			
CMP	1	Key V82E If ave G routine on, go to 4		2,140	V82 computations based on two-body conic equations and may give erroneous results during transearth/lunar coasting. TFF display may be incorrect if return trajectory is hyperbolic.
	2	FL V04 N12			
		Option code	00002		
		CMC assumed option (1 = CSM active 2 = LM active)	0000X		
		Accept PRO Reject V22E (load desired option)			
	3	FL V06 N16			
		GET event	00XXX. HRS 000XX. MIN 0XX.XX SEC		Time for state vector integration. TFF and N32 continue to be measured from present time rather than N16 input time. CMC sets time option initially to zero, meaning present time.
		Accept PRO Reject Key V25E Load desired time			

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	4	FL V16 N44		2,140	If average G on, display updates every 2 seconds.
		Ha Hp	XXXX.X NM XXXX.X NM		Above launch pad radius for earth orbit or above landing site radius for lunar orbit. Calculations are subject to limitations of two-body approximation and yield reasonable results if vehicle close to earth or moon.
		TFF	XXBXX MIN-SEC		Time of free fall to 49.4 NM (300,000 feet) for earth orbit, or 5.8 NM (35,000 feet) for lunar orbit. TFF reads -59B59 if Hp >49.4/5.8 NM; under these conditions, time from perigee/perilune available by keying N32. If average G off and Hp <49.4/5.8 NM, TFF counts down. For N32, if average G off and Hp >49.4/5.8 NM, time from perigee/perilune counts down.
		Accept PRO Reject V32E Recycle to 3			Recalculates orbital parameters. (Valid only if average G off.)

(V82) ORBIT PARAMETER DISPLAY (R30)

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.11.2 RENDEZVOUS NAVIGATION		
		<u>4.11.2.1 (P20) CSM Rendezvous Navigation</u>		Purpose: • Control CSM attitude and optics to acquire LM in SXT FOV and to point CSM transponder at LM or to control CSM attitude to acquire LM along CSM +X axis depending on option selected by crew. • To update either LM or CSM state vector depending on crew selection. Update is based on optical tracking or VHF ranging data. The uplink activity light indicates R61 requesting an automatic maneuver during rendezvous. For rendezvous navigation W-matrix should not be initialized to magnitudes >328 fps and 51,647 feet (N99 display).
		CMC - on (req), 4.8.1.3		
		ISS - on & orient known (req), 4.8.1.3 & 4.14		
		SCS - on (desired), 4.8.4.2		Provides total attitude and rate monitoring.
		Opt pwr up (req), 4.8.1.4		Not required for VHF update.
		VHF AM ranging mode sel (req), 4.5.6.6		Not required for optical update.
CDR		CMC ATT - IMU (verify)	1	
		LOGIC 2/3 PWR - on (up) (if no SCS)	7	Required for control and display functions.
		Key V93E (if necessary)	2,140	If hour or more has elapsed since W-matrix initialization or if state vector has not been updated via P27.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	1	Sel Tot Att disp, 4.7.2.5		
	2	Sel Att Cont mode, 4.7.1		
CMP	3	Key V37E 20E	2,140	Selection of P20 automatically selects preferred tracking attitude option and LM state vector update option. Crew may exercise control of these options through use of the following extended verbs. V76E - Selects preferred tracking attitude. V77E - Selects +X axis tracking attitude. V80E - Selects LM state vector update. V81E - Selects CSM state vector update. V87E - Allow R22 to accept VHF range data. V88E - Inhibit acceptance of VHF range data.
		Poss PROG alarm (4.8.1.16)		R02.
		(R60, Attitude Maneuver Routine)		Provides for maneuver (auto or manual) to attitude specified by option selected. R60 called only if maneuver >10° (in any axis) required. Otherwise maneuver performed by R61.
		(If UPLINK ACTY lt on Key V58E)		Must key V58E in order to get R60 (V50 N18), except for initial entry to P20. R61 resets V50 N18 flag; V58E sets flag to allow R60 if subsequent auto maneuver >10° required.

(P20) CSM RENDEZVOUS NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	4	Poss FL V50 N18 (auto mnvr request) (2 sec priority) If req GMBL angle change >10°	2,140	DAP will point preferred or X-axis at LM but will not constrain roll about tracking axis. If required maneuver <10°, maneuver performed by R61.
		R, P, Y XXX.XX DEG		Required gimbal angles.
CDR		Accept SC CONT - CMC CMC MODE - AUTO	1	
CMP		PRO	2,140	This may be performed second time as attitude trim.
		V06 N18 R, P, Y XXX.XX DEG Mon auto mnvr on FDAI		Priority display. At completion of maneuver, display will revert to FL V50 N18.
		Reject Key V62E RHC - null FDAI err needles Recycle 4		Provides reference for manual maneuver.
CDR		or SC CONT - SCS (or CMC mode ≠ auto)	1	To update display without performing maneuver.
CMP		PRO Recycle 4	2,140	
		When att satisfactory ENTR		Terminates Attitude Maneuver Routine, R60. (Routine R61 will continue to compute and maintain selected attitude (option) as long as SC control CMC AUTO and RHC not moved out of detent.) UPLINK ACTY light will be lit if V50 N18 flag not set and tracking angles >10 degrees.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		a. If opt sighting mrks desired, go to 5		
	or	b. If BU opt (COAS) sighting mrks desired, go to 8		
	or	c. If VHF ranging data update desired, Key V87E Go to 11	2,140	
		(R52, Automatic Optics Positioning)		
	5	OPT ZERO - OFF OPT MODE - CMC If TA >50°	122	If TA >50°, trunnion driven to upper limit (≈49.7754°) and held at this angle.
		a. RHC - man mnvr to selected tracking att		Key V16 N22 for desired gimbal angles. Key V16 N92 for desired optics angles.
CDR	or	b. SC CONT - CMC CMC MODE - AUTO Key V58E if RHC moved from detent	1 2,140	
		(R21, Rendezvous Tracking Sighting Mark Routine)		To perform sighting marks on LM.
	6	Key V57E		

(P20) CSM RENDEZVOUS NAVIGATION

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	7	FL V51 N45 (please mrk)		2,140	
		Mrks (VHF/opt)	XXBXX MKS		Number of marks processed by R22. Two most significant digits display VHF ranging marks. Two least significant digits display optics marks [either SXT or backup optics (COAS) marks]. Optics mark counter does not distinguish between backup and primary marks.
		TF GETI (next burn)	XXBXX MIN-SEC		Constraint - R2 cannot be >59B59 at this point. If TF GETI >59 min 59 sec, display is limited. N35 may be used to get full time to ignition.
		MGA (next burn)	XXX.XX DEG		MGA displayed as -00002 at this point if IMU not on and orientation known (REFSMMAT flag reset). Otherwise, MGA at GETI displayed if CSM +X axis aligned with initial thrust direction.
		OPT MODE - MAN		122	
		OHC - ctr LM in SXT			
		MARK pb - push			
		Accept Repeat mrk proced			If more marks desired.
		or PRO		2,140	If sufficient marks have been made. To ensure processing of last mark, wait 15 seconds before proceeding. This allows for previous mark to be processed. If PRO done too soon, one of last two marks may be ignored.
		OPT MODE - CMC		122	
		Go to 11			
		Reject MARK REJ pb - push			
		Repeat mrk proced			

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R23, Backup Rendezvous Tracking Sighting Mark Routine)		To perform sighting marks on LM using backup optics (COAS).
CMP	8	Key V54E	2,140	
	9	FL V06 N94		
		SA XXX.XX DEG		SA - Shaft angle (nominal = 00000).
		TA XX.XXX DEG		TA - Trunnion angle (nominal = 57470).
		Accept PRO Reject Key V24E Load desired data		
	10	FL V53 N45 (request alt LOS mrk)		
		Mrks (VHF/opt) XXBXX MKS		Number of marks processed by R22. Two most significant digits display VHF ranging marks. Two least significant digits display optics marks [either SXT or backup optics (COAS) marks]. Optics mark counter does not distinguish between backup and primary marks.
		TF GETI (next burn) XXBXX MIN-SEC		Constraint - R2 cannot be >59B59 at this point. If TF GETI >59 min 59 sec, display is limited. N35 may be used to get full time to ignition.
		MGA (next burn) XXX.XX DEG		MGA displayed as -00002 at this point if IMU not on and orientation known (REFSMMAT flag reset). Otherwise, MGA at GETI displayed if CSM +X axis aligned with initial thrust direction.
		RHC - Align LM in COAS		
		ENTR		Alternate LOS mark.

(P20) CSM RENDEAVOUS NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	Accept	Repeat mrk proced		If more marks desired.
	or	PRO	2,140	If sufficient marks have been made. To ensure processing of last mark, wait 15 seconds before proceeding. This allows for previous marks to be processed. If PRO done too soon, one of the last two marks may be ignored.
	Reject	V86E Repeat mrk proced		Rejects previous mark.
		(R22, Rendezvous Tracking Data Processing Routine)		
	11	Poss FL V06 N49 (2 sec priority) ΔR XXXX.X NM ΔV XXXX.X FPS		Excessive update parameters. To change ΔR and ΔV threshold values, refer to 4.8.1.10.
		Source code 0000X.		00001 = Optics (CMC does not differentiate between SXT and COAS marks). 00002 = VHF ranging.
		Wait 2 sec		Priority display. Will not respond to DSKY input until after 2 seconds.
		Accept PRO		Incorporates update data.
		Reject Key V32E		Does not incorporate update data. (V32E will erase mark data from positions 1, 2, and 3 if R3 = 00001.)

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	12	To term P20 & all other prog running		
		Key V37E 00E	2,140	
	or	To term P20 only		
		Key V56E		If V56 keyed in during computation in P34/P35, these computations will be restarted from beginning.
		Poss FL V37		FL V37 only if no other program active.
		Key XXE		
	13	Set opt cont		
		OPT ZERO - ZERO	122	
		OPT PWR - OFF	100	
		RETCL BRT tw - DIM	122	

(P20) CSM RENDEZVOUS NAVIGATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.11.2.2	(V83) Rendezvous Parameter Display #1 (R31)		Displays CMC calculated rendezvous parameters (range, range rate, and theta).
		CMC - on (req), 4.8.1.3		
		ISS - on & orient known (req), 4.8.1.3 & 4.14		Required for meaningful display of theta.
CMP	1	Key V83E	2,140	
		Poss OPR ERR		If another extended verb active.
	2	FL V16 N54		Display updated at 2-second intervals.
		Range XXX.XX NM		Range and range rate based on stored state vectors. Range and range rate displays may degrade considerably at ranges below ≈0.3 to 0.5 NM depending on marking schedules and resultant CMC navigation accuracy. Once this routine has started, changes to state vector caused by optics mark or VHF sample will not be reflected in displayed parameters.
		Range rate XXXX.X FPS		(-) range rate indicates closing. This calculation not sufficiently accurate for reliable terminal closing values. It should not be utilized without good visual cues.
		Theta (lcl horiz/ CSM +X) XXX.XX DEG		Theta - Angle included between +Xsc axis and local horizontal. Angle in range 0° to 180° indicates +Xsc axis is above local horizontal plane. Total range: 0° to 360°.
		PRO Return to prog in progress		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.11.2.3 (V85) Rendezvous Parameter Display #2 (R34)		Displays CMC calculated rendezvous parameters (range, range rate, and phi).
		CM - on (req), 4.8.1.3		
		ISS - on & orient known (req), 4.8.1.3 & 4.14		Required for meaningful display of phi.
		Opt pwr up (req), 4.8.1.4		Required for meaningful display of phi.
CMP	1	Key V85E	2,140	
		Poss OPR ERR		If another extended verb active.
	2	FL V16 N53		Display updated at 2-second intervals.
		Range XXX.XX NM Range rate XXXX.X FPS		Range and range rate computed based on stored LM and CSM state vectors. (-) range rate indicates closing. Range and range rate displays may degrade considerably at ranges below ≈0.3 to 0.5 NM depending on marking schedules and resultant CMC navigation accuracy. Once this routine has started, changes to state vector caused by optics mark or VHF sample will not be reflected in displayed parameters.
		Phi (lcl horiz/ SLOS) XXX.XX DEG		Phi - Angle included between optics starline of sight and a local horizontal. Angle in range 0° to 180° indicates SLOS is above local horizontal plane. Total range: 0° to 360°.
		PRO Return to prog in progress		

(V85) RENDEZVOUS PARAMETER DISPLAY #2 (R34)

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.11.2.4	(V90) Rendezvous Out of Plane Display (R36)		Displays CMC calculated rendezvous out-of-plane parameters (Y, Ydot, Psi) for vehicles selected in 2.
		CMC - on (req), 4.8.1.3		
CMP	1	Key V90E	2,140	
		Poss OPR ERR		If another extended verb active.
	2	FL V04 N12 Option code 00002. CMC assumed option 0000X. (1 = CSM active; 2 = LM active) Accept PRO Reject V22E (load desired option)		
	3	FL V06 N16 GET event 00XXX. HRS 000XX. MIN 0XX.XX SEC Accept PRO Reject Key V25E Load desired GET event		GET for which out-of-plane parameters desired. N16 initialized to TIG(N33) before this display, and after recycle. (Present time indicated by all zeros.)

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	4	FL V06 N90 (rndz out of plane param)	2,140	
		Y XXX.XX NM		Y - Distance along V x R of passive vehicle.
		Ydot XXXX.X FPS		Ydot = Rate of change of Y. +, increasing; -, decreasing.
		Psi XXX.XX DEG		Psi - Angle between active vehicle orbital plane and LOS to passive vehicle projected into horizontal plane. Range: 0° to 360°.
		Accept PRO Exit R36		
		Reject Key V32E Return to 3 (adjust GET event)		To obtain additional data point.

(V90) RENDEZVOUS OUT OF PLANE DISPLAY (R36)

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.11.2.5 (V89) Rendezvous Final Attitude (R63)		Calculates final gimbal angles required to point either CSM +X axis or preferred tracking axis at LM. Provides auto maneuver to selected attitude by calling R60.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (desired), 4.8.4.2 RCS DAP - load & activate (req), 4.8.2.1		
CMP	1	Key V37E 00E	2,140	R63 may be selected from P00 only.
	2	Sel ISS Tot Att Disp, 4.7.2.5		Both FDAIs recommended so that either reference system (IMU or GDC) may be monitored. (CMC attitude error and rate display available.)
	3	Key V89E		
		Poss PROG alarm (4.8.1.16)		R02.
	4	FL V04 N06 Option code 00003 CMC assumed option 0000X (00001 - Pref; 00002 - +X axis) Accept PRO Reject Key V22E Load desired option		
	5	FL V06 N18 (computed GMBL angles) R, P, Y XXX.XX DEG Accept PRO Reject Key V32E (to update disp) or Key V34E (to term routine)		Computed required gimbal angles at selected tracking attitude (preferred or +X axis) if present IMU orientation maintained.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R60, Attitude Maneuver Routine)		Provides maneuver (automatic or manual) to attitude selected in 4.
CMP	6	FL V50 N18 (CMC auto request)	2,140	
		R, P, Y XXX.XX DEG		Required gimbal angles.
CDR		Accept SC CONT - CMC	1	
		CMC MODE - AUTO		
CMP		PRO	2,140	
		Go to 7		
		Reject Key V62E		Provides reference for manual maneuver.
		RHC - null FDAI err needles		
CDR		or SC CONT - SCS	1	Recomputes desired attitude without performing auto maneuver.
		(or CMC MODE ≠ AUTO)		
CMP		PRO (to update disp)	2,140	
		Recycle 6		
		or ENTR		Terminates R60.
		Exit R60		
	7	V06 N18 (auto mnvr)		
		R, P, Y XXX.XX DEG		
		Mon auto mnvr on FDAI		
		Return to 6		

(V89) RENDEZVOUS FINAL ATTITUDE (R63)

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.11.2.6 (P76) TARGET DELTA V		Provides LM maneuver parameters to CMC for updating CMC knowledge of LM state vector. P76 may be performed concurrently with P20. If P20 operating, discontinue marking and ensure data incorporation complete in P20 by reviewing N45 mark counters prior to P76 state vector changes. If P76 completed prior to LM burn, delay P20 state vector updates until after LM maneuver executed.
		CMC - on (req), 4.8.1.3		
CMP	1	Key V37E 76E	2,140	
	2	FL V06 N33 GETI — 00XXX. HRS 000XX. MIN 0XX.XX SEC Accept PRO Reject Key V25E Load desired GETI		
	3	FL V06 N84 ΔVX, Y, Z (LM lcl vert) — XXXX.X FPS Accept PRO Reject Key V25E Load desired data		CMC updates LM state vector and zeros mark counters.
	4	FL V37 Key XXE		R00.

NORMAL BACKUP

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.12 PRETHRUSTING		
		4.12.1 ORBIT CHANGE PRETHRUSTING		If P37 Return to Earth Program desired, go to 4.12.1.2.
		4.12.1.1 <u>(P30) External Delta V Prethrusting</u>		Accepts targeting parameters from sources external to CMC and computes, therefrom, required velocity and other initial conditions required by CMC for execution of ΔV maneuver. Targeting parameters include time of ignition (TIG) and impulsive ΔV along CSM local vertical axes at TIG. P30 displays, to flight crew and MSFN, certain specific dependent variables associated with desired maneuver for approval by flight crew/MSFN.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14		ISS must be on and its orientation known to obtain middle gimbal display (step 5).
CMP	1	Key V37E 30E	2,140	At this point, P30 sets TRACK and UPDATE flags.
	2	FL V06 N33 GETI, stored 00XXX. HRS 000XX. MIN 0XX.XX SEC Accept Rcd GETI PRO Reject V25E, load desired GETI		
	3	FL V06 N81 (ΔV compnts) ΔVX, Y, Z (lcl vert at GETI) XXXX.X FPS		Stored ΔV components along local vertical axes at GETI. If P30 for estimating perilune, load N81: +00000 +00010 +00000

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP		Accept PRO Reject V25E, load desired data		2,140	PRO option resets UPDATE flag and sets external ΔV flag.
	4	FL V06 N42 (calculated thrust parameters)			
		Ha Hp ΔV (req)	XXXX.X NM XXXX.X NM XXXX.X FPS		Altitudes above launch pad radius if earth orbit or above lunar radius at most recently defined landing site. Measurements limited to 9999.9 NM. Calculated Ha and Hp in P30 considerably in error for long burns and should be ignored because parameters computed (assuming an impulsive ΔV) at time of ignition along CSM local vertical axis. ΔV magnitude of impulsive ΔV vector at GETI.
		Coord parameters with MSFN (if available)			
		Accept PRO Reject Reselect P30 or P27 Load new parameters			
	5	FL V16 N45			
		Mrks (VHF/opt)	XXBXX MKS		Number of marks processed by R22. Two most significant digits display VHF ranging marks. Two least significant digits display optics marks [either SXT or backup optics (COAS) marks]. Optics mark counter does not distinguish between backup and primary marks.
-59:59		TF GETI (next burn)	XXBXX MIN-SEC		Constraint: R2 cannot be >59B59 at this point. If TF GETI >59 min 59 sec, display limited. For full time to ignition display, use N35.
		MGA (next burn)	XXX.XX DEG		MGA displayed as -00002 at this point if IMU not on and orientation known (REFSMMAT flag reset). Otherwise, MGA at GETI displayed if CSM +X axis aligned with initial thrust direction.

(P30) EXTERNAL DELTA V PRETHRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Rcd values		
		PRO	2,140	
		Align GDC to IMU, 4.8.4.6		
	6	FL V37 Key XXE		If average G on, R00 turns off average G, and zeros rendezvous mark and VHF ranging mark counters. Otherwise, counters not zeroed. R00 also sets or resets RNDZ, TRACK, and UPDATE flags, depending on which programs in progress or called. R00 may recycle into P20 under certain conditions.
		Go to (P40) G&N/SPS Thrusting, 4.13.2.1		
		or (P41) G&N/SM RCS Thrusting, 4.13.2.2		
		or SCS Thrusting, 4.13.3		
		or (P52) IMU Realign, 4.14.1.2		IMU realign should be selected if MGA unsatisfactory in step 5.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.12.1.2 (P37) Return to Earth Program		Computes return-to-earth trajectory for CSM from outside lunar sphere of influence at TIG. P37 computes and displays preliminary series of parameters based on conic trajectory and crew-specified time of ignition, maximum change in velocity, and entry angle. Upon acceptance, P37 computes and stores target parameters for use by P40 or P41. P37 not restart protected and must be reselected if a restart occurs. P37 assumes no MSFN contact required. Provides two modes of operation: fuel critical and nonfuel critical. Nonfuel critical mode can be used to move landing site by adjusting maximum change in velocity.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14 SCS - on (desired), 4.8.4.2 DAP Data Load - complete (req), 4.8.2.1 (P30) External ΔV Prethrusting (if desired), 4.12.1.1		Desired to provide MGA display (step 10).
CMP	1	Key V37E 37E	2	
	2	FL V06 N33 (GETI) 00XXX. HRS 000XX. MIN 0XX.XX SEC Accept Rcd GETI PRO Reject V25E, load desired values		Ground elapsed time of ignition.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	3	FL V06 N60 Blank	2	R2 and R3 initially 00000.
		V Pred XXXXX. FPS		Maximum allowable change in velocity. To compute fuel critical trajectory, zeros should be loaded in R2. If slowdown desired, load negative value.
		Gamma EI XXX.XX DEG		Flight path angle between inertial velocity vector and local horizontal at entry interface altitude, 65.8 NM (400,000 feet). Minus indicates flight path below horizontal plane. If zero-loaded in R3, computation solved to hit center of entry corridor. Otherwise, computation solved to hit angle entered.
		Accept Rcd R2 value PRO		Record R2 for subsequent use. Both input scaler (desired ΔV) and output scaler (entry velocity) use VPRED register of N60. Therefore, original ΔV input no longer in N60. R2 of N56 contains magnitude of original input.
		Reject V22E, V23E, or V25E Load desired values Poss PROG alarm (comp problem) FL V05 N09 00605 (solution does not converge; excessive iterations) 00612 (state vector in wrong sphere of influence) V32E RSET, return to 2		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		or FL V37 Key V05 N09E (to verify alarm) 20607 (no solution from time theta or time radius routine) 20610 (state vector at TIG <400K feet) KEY REL 37E, return to 2	2	
	4	FL V06 N61 (entry data) Impact Lat (+N) XXX.XX DEG Impact Long (+E) XXX.XX DEG Blank Accept Rcd values PRO Reject V32E, return to 2		
	5	FL V06 N39 ΔT Trans 00XXX. HRS 000XX. MIN 0XX.XX SEC Accept Rcd values PRO Reject V32E, return to 2		Time required for transfer from GETI to time of entry at 65.8 NM (400,000 ft) above Fischer ellipsoid.
	6	FL V06 N60 Blank V Pred XXXXX. FPS Gamma EI XXX.XX DEG		

(P37) RETURN TO EARTH PROGRAM

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Accept Rcd values		
		PRO	2	
		Reject V32E, return to 2		
	7	FL V06 N81 (ΔV compnts)		
		ΔVX, Y, Z (lcl vert at GETI) XXXX.X FPS		
		Crew option		
		Key N40E		
		TF GETI XXBXX MIN-SEC		
		VG XXXX.X FPS		
		ΔV (accum) XXXX.X FPS		
		Rcd VG (lcl vert vel to be gained)		
		KEY REL		
		Accept Rcd N81 values		
		PRO		
		If first pass, recycle to 4		
		Poss PROG alarm (comp problem)		
		FL V05 N09		
		00605 (solution does not converge; excessive iterations)		
		00613 (re-entry angle out of limits)		
		Key V32E, return to 2		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	8	FL V04 N06 (propul code) 00007 (option code) 0000X (CMC assumed option) Blank Accept PRO Go to 9 Reject V22E, load desired option Recycle 8	2	CMC initially sets 00001 in R2 to indicate data intended for SPS thrust (P40). 00002 indicates RCS (P41). DAP Data Load should be complete before PRO.
	9	FL V06 N33 GETI 00XXX. HRS 000XX. MIN 0XX.XX SEC Rcd data PRO		External ΔV flag reset at this point.
N	10	FL V16 N45 (mnvr data) Mrks (VHF/opt) XXBXX MKS TF GETI XXBXX MIN-SEC MGA XXX.XX DEG If IMU not aligned R3 -00002 PRO		Marks (VHF/optics) not meaningful to this program. MGA (+) at TIG if CSM +X axis aligned with initial thrust direction.
	11	FL V37 Key XXE Go to Thrusting, 4.13		If average G on, R00 turns off average G and zeros rendezvous mark and VHF ranging mark counters. Otherwise, counters not zeroed. R00 also sets or resets RNDZ, TRACK and UPDATE flags, depending on which programs in progress or called. R00 may recycle into P20 under certain conditions.

STA/T STEP	PROCEDURE	PANEL	REMARKS
4.12.2	RENDEZVOUS PRETHRUSTING		
4.12.2.1	(P32/P72) Co-elliptic Sequence Initiation		P32 Co-elliptic Sequence Initiation (CSM active) or P72 Co-elliptic Sequence Initiation Targeting (LM active) calculates parameters associated with CSI and with either P33 or P73 Constant Delta Altitude (CDH) ΔV Maneuvers. Successful completion dependent upon assumptions: a. Prescribed angle (E) exists at selected GETI (TPI). b. GETI (CDH) -GETI (CSI), and GETI (TPI) -GETI (CDH), each >10 minutes. c. CSI burn parallel to passive vehicle orbital plane (crew may modify), impulsive, and in active vehicle horizontal plane. d. CDH maneuver minimizes ΔH variations and resulting Hp >85 for EO or >5.8 NM for LO. e. Computed variables may be stored for later MSFN verification. P32 or P72 may be performed concurrently with P20. If P20 operating, optic sighting marks on LM may be initiated by keying V57E (R21) or V54E (R23) and referring to 4.11.2.1, steps 5-7 or 8-10, respectively. Also if P20 operating, VHF ranging data state vector update may be initiated by configuring for VHF AM Ranging Mode, 4.5.6.6, and keying V87E. Keying V34E terminates P32 or P72 at any flashing display.

STA/T	STEP	PROCEDURE		PANEL	REMARKS
		CMC - on (req), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.1			Required if P20 running and automatic state vector update desired and, if P32, for meaningful MGA display during final N45 display (step 8).
CMP	1	Key V37E 32E/72E		2,140	
	2	FL V06 N11 GETI (CSI)	00XXX. HRS 000XX. MIN 0XX.XX SEC		
		Accept Rcd GETI (CSI) PRO Reject Key V25E Load desired GETI (CSI)			
	3	FL V06 N55 N	0000X		Future active vehicle apsidal crossing (perilune or apolune). Should load to define future crossing at which CDH maneuver should occur; e.g., 00001 = first, 00002 = second, etc.
		E	XXX.XX DEG		Elevation angle at GETI (TPI).
		CENTANG	00000		Initially 00000 (except for recycle from step 5) and used by CMC as an option code. If any nonzero value loaded in R3, CMC calculates CDH parameters for GETI (CDH) at N (180°) from CSI maneuver where N specified by value set in R1.

(P32/P72) CO-ELLIPTIC SEQUENCE INITIATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Accept Rcd data		
		PRO	2,140	
		Reject Key V25E		
		Load desired data		
	4	FL V06 N37		
		GETI (TPI) 00XXX. HRS		
		000XX. MIN		
		0XX.XX SEC		
		Accept Rcd GETI (TPI)		
		PRO		
		Go to 8		
		Reject Key V25E		
		Load desired GETI (TPI)		
	5	CMC Computes CSI & CDH parameters		
		Poss FL V05 N09		
		00600 no solution of LOS at TPI		
		00601 post CSI Hp <5.8 NM (<85 NM for EO)		
		00602 post CDH Hp <5.8 NM (<85 NM for EO)		
		00603 CDH -CSI <10 min		
		00604 TPI -CDH <10 min		
		or Computed GETI (CDH) >input GETI (TPI) in step 4		
		00605 no solution & CMC iterations >15		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		00606 CSI ΔV >1000 fps (for two consecutive iterations)	2,140	
		Key V32E Return to 2		To adjust input parameters.
		FL V06 N75 Δ Alt (CDH) XXXX.X NM ΔT (CDH -CSI) XXBXX MIN-SEC ΔT (TPI -CDH) XXBXX MIN-SEC Rcd values PRO		Maximum reading (displayed) in R2 and R3 is 59B59. Only minutes and seconds displayed although time computation done in hours, minutes, and seconds. Computed CDH and TPI times can be determined by calling N13 and N37, respectively.
	6	FL V06 N81 ΔVX, Y, Z (lcl vert) XXXX.X FPS		CMC calculated components of ΔV (in local vertical coordinates) for CSI.
		Accept Rcd values PRO Reject Key V25E Load desired values		To modify ΔV (local vertical) to correct for out of planeness, key V90E (R36). Use data obtained from R36 to determine desired ΔV (local vertical). Modification will not impact N82 of step 7.
	7	FL V06 N82 ΔVX, Y, Z (lcl vert) XXXX.X FPS Rcd values PRO		CDH velocity components based on original CSI values of step 6, and cannot be written over.
	8	FL V16 N45 Mrks XXBXX MKS		Number of marks processed by R22. Two most significant digits display VHF ranging marks. Two least significant digits display optics marks [either SXT or backup optics (COAS) marks].

(P32/P72) CO-ELLIPTIC SEQUENCE INITIATION

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP		TF GETI (CSI)	XXBXX MIN-SEC	2,140	Time from CSI ignition. Maximum reading is 59B59. -, before; +, after.
		MGA	-0000X		-00001 for other than final pass. -00002 for final pass (and IMU not aligned if P32).
		Or IMU ALIGNED & P32	+XXX.XX DEG		Middle gimbal angle (yaw): +XXX.XX DEG for final pass and IMU aligned (if +X axis aligned to initial thrust direction).
		To continue mrk process Key V32E Return to 5			
		or To term mrk process & do fnl pass thru prog PRO Return to 5			
		or After fnl pass thru prog PRO			
	9	FL V37 Key XXE			R00.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.12.2.2 (P33/P73) Constant Delta Altitude		P33 Constant Delta Altitude (CSM active) or P73 LM Constant Delta Altitude Targeting (LM active) computes parameters associated with CDH maneuver. Successful completion dependent upon prior completion of P32 for P33, or P72 for P73.
				P33 or P73 may be performed concurrently with P20. If P20 operating, optic sighting marks on LM may be initiated by keying V57E (R21) or V54E (R23) and referring to 4.11.2.1, steps 5-7 or 8-10, respectively. Also if P20 operating, VHF ranging data state vector update may be initiated by configuring for VHF AM Ranging Mode, 4.5.6.6, and keying V87E.
				Keying V34E terminates P33 or P73 at any flashing display.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14		Required if P20 running and automatic state vector desired and, if P33, for meaningful MGA display during final N45 display in step 5.
		If P33 - P32 (complete), 4.12.2.1 If P73 - P72 (complete), 4.12.2.1		P33 or P73 computations based upon GETI (TPI), and elevation angle (E) defined in P32 or P72.
CMP	1	Key V37E 33E/73E	2,140	
	2	FL V06 N13 GETI (CDH) 00XXX. HRS 000XX. MIN 0XX.XX SEC		

(P33/P73) CONSTANT DELTA ALTITUDE

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Accept Rcd GETI (CDH)		
		PRO	2,140	
		Go to 5		
		Reject Key V25E		
		Load desired GETI (CDH)		
	3	CMC computes CDH parameters		
		Poss FL V05 N09		
		00611 (No GETI for given E)		
		PRO, go to FL V06 N75		To force GETI (CDH) solution.
		or Key V32E, return to 2		To adjust input parameters.
		FL V06 N75		
		Δ Alt (CDH) XXXX.X NM		Maximum reading (displayed) in R2 and R3 is 59B59. Only minutes and seconds displayed although time computation done in hours, minutes, and seconds.
		ΔT (TPI -CDH) XXBXX MIN-SEC		
		ΔT (TPI -TPI) XXBXX MIN-SEC		TPI computed minus TPI computed in P32 or P72. TPI time, computed in P33 or P73, can be determined by calling N37.
		Rcd values		
		PRO		
	4	FL V06 N81		CMC calculated components of ΔV (in local vertical coordinates) for CDH.
		ΔVX, Y, Z (lcl vert) XXXX.X FPS		
		Accept Rcd values		
		PRO		
		Reject Key V25E		To modify ΔV (local vertical) to correct for out of planeness, key V90E (R36). Use data obtained from R36 to determine desired ΔV (local vertical).
		Load desired values		

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	5	FL V16 N45		2,140	
		Mrks	XXBXX MKS		Number of marks processed by R22. Two most significant digits display VHF ranging marks. Two least significant digits display optics marks [either SXT or backup optics (COAS) marks].
		TF GETI (CDH)	XXBXX MIN-SEC		Time from CDH ignition. Maximum reading is 59B59. -, before; +, after.
		MGA	-0000X		-00001 for other than final pass. -00002 for final pass (and IMU not aligned if P33).
		Or IMU ALIGNED & P33	+XXX.XX DEG		Middle gimbal angle (yaw): +XXX.XX DEG for final pass and IMU aligned (if +X axis aligned to initial thrust direction).
		To continue mrk process Key V32E Return to 3			
		or To term mrk process & do fnl pass thru prog PRO Return to 3			
		or After fnl pass thru prog PRO			
	6	FL V37 Key XXE			R00.

(P33/P73) CONSTANT DELTA ALTITUDE

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.12.2.3 (P34/P74) Transfer Phase Initiation		P34 Transfer Phase Initiation (CSM active) or P74 LM TPI Targeting (LM active) calculates required ΔV and other initial conditions required by CMC for CSM execution (P34), or by LGC for LM execution (P37), of TPI maneuver, given: a. Time of ignition, GETI (TPI), or elevation angle (E) of active-to-passive LOS at GETI (TPI). b. Central angle of transfer (CENTANG) of passive vehicle from GETI (TPI) to time of intercept. c. Calculates GETI (TPI) given E, or E given GETI (TPI). P34 or P74 may be performed concurrently with P20. If P20 operating, sighting marks on LM may be initiated by keying V57E (R21) or V54E (R23) and referring to 4.11.2.1, steps 5-7 or 8-10, respectively. Also if P20 operating, VHF ranging data state vector update may be initiated by configuring for VHF Ranging Mode, 4.5.6.6, and keying V87E.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14		Required if P20 running and automatic state vector desired and, if P34, for meaningful MGA display during final N45 display (step 8).
CMP	1	Key V37E 34E/74E	2,140	
	2	FL V06 N37 GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC		

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP		Key V25E Load desired GETI (TPI) Rcd GETI (TPI) PRO		2,140	Load desired GETI (TPI) if CMC computation of E desired. For a specified value of E and CMC computation of GETI (TPI), load an initial value of GETI (TPI). Loaded value should be within 30 minutes of actual.
	3	FL V06 N55			
		NN	0000X.		Integration method and number of precision offset computations desired. NN initially 0.
		E	XXX.XX DEG		Elevation angle.
		CENTANG	XXX.XX DEG		Central angle of passive vehicle from GETI (TPI) to time of intercept.
		Accept Rcd CENTANG & E PRO Go to 8 Reject Key V25E Load desired data			Load desired NN in R1: 0, conic integration; X, precision integration with (X) target offsets. Desired E in R2, CMC computes GETI (TPI). +00000 in R2, CMC computes E.
	4	If E specified (CMC computes GETI) Poss FL V05 N09 00611 (no GETI for given E) PRO Return to 2 (adj input parameters)			

(P34/P74) TRANSFER PHASE INITIATION

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP		FL V06 N37		2,140	
		GETI (TPI)	00XXX. HRS 000XX. MIN 0XX.XX SEC		
		Rcd GETI (TPI) PRO Go to 5			
	or	If +00000 specified for E (CMC computes E) FL V06 N55			
		NN	0000X.		Integration method and number of precision offset computations desired.
		E CENTANG	XXX.XX DEG XXX.XX DEG		CMC computed E.
		Rcd E PRO			
	5	FL V06 N58			
		Hp	XXXX.X NM		Perigee altitude above launch pad radius for earth orbit, or perilune altitude above landing site radius for lunar orbit, after TPI maneuvers. Display meaningless if Hp >9999.9 NM.
		ΔV (TPI)	XXXX.X FPS		Required impulsive ΔV to accomplish TPI maneuver at GETI (TPI).

STA/T STEP	PROCEDURE		PANEL	REMARKS
CMP	ΔV (TPF)	XXXX.X FPS	2,140	Required impulsive ΔV to accomplish intercept maneuver (TPF) at calculated time of intercept.
	Rcd data PRO If not fnl pass, go to 7			To obtain central angle of active vehicle, key V06 N52.
6	FL V06 N81 (fnl pass only) ΔVX, Y, Z (lcl vert)	XXXX.X FPS		Required impulsive ΔV components in active vehicle local vertical coordinates.
	Accept Rcd ΔV (lcl vert) PRO Reject Key V25E Load desired ΔV (lcl vert)			To modify ΔV (lcl vert) to correct for out of planeness, key V90E (R36). Use data obtained from R36 to determine desired ΔV (local vertical).
7	FL V06 N59 ΔV 1, 2, 3 (LOS) Rcd ΔV (LOS) PRO	XXXX.X FPS		Required impulsive ΔV components in an orthogonal coordinate system oriented along CSM to LM LOS in P34, or along LM to CSM LOS for P74. (For complete definition, refer to GSOP section 5.4.2.2 of R577.)
8	FL V16 N45 Mrks	XXBXX MKS		Number of marks processed by Rendezvous Data Processing Routine, R22. Two most significant digits display VHF ranging marks. Two least significant digits display optics marks [either SXT or backup optics (COAS) marks].
	TF GETI (TPI)	XXBXX MIN-SEC		Time from ignition. Max reading is 59B59. -, before; +, after.
	MGA	-0000X		-00001 for other than final pass. -00002 for final pass (and IMU not aligned in P34).

(P34/P74) TRANSFER PHASE INITIATION

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Or IMU ALIGNED & P34 +XXX.XX DEG	2,140	Middle gimbal angle (yaw): +XXX.XX DEG for final pass and IMU aligned (if +X axis aligned to initial thrust direction).
	To continue mrk process Key V32E Return to 4		
	or **To term mrk process & do fnl pass thru prog** PRO Return to 4		
	or After fnl pass thru prog PRO If P74, xmit all mnvr parameters to LM		
9	FL V37 Key XXE		ROO.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.12.2.4	(P35/P75) Transfer Phase Midcourse		P35 Transfer Phase Midcourse (CSM active) or P75 TPM Targeting (LM active) calculates required ΔV and other initial conditions required by CMC for CSM (P35), or by LGC for LM (P75), execution of next midcourse correction of transfer phase.
				P35 or P75 may be performed concurrently with P20. If P20 operating, sighting marks on LM may be initiated by keying V57E (R21) or V54E (R23) and referring to 4.11.2.1, steps 5-7 or 8-10, respectively. Also if P20 operating, VHF ranging data state vector update may be initiated by configuring for VHF Ranging Mode, 4.5.6.6, and keying V87E.
		CMC - on (req), 4.8.1.3 If P35 - P34 (complete), 4.12.2.4 If P75 - P74 (complete), 4.12.2.4		Time of intercept computed and stored by P34 (P74) required for P35 (P75) computations. Type of integration (conic or precision) and number of offsets determined by P34 (P74) computations.
		ISS - on & orient known (desired), 4.8.1.3 & 4.14		Required if P20 running and automatic state vector desired and, if P35, for meaningful MGA display during final N45 display (step 4).
CMP	1	Key V37E 35E/75E Go to 4	2,140	
	2	FL V06 N81 (fnl pass only) ΔV X, Y, Z (lcl vert) XXXX.X FPS		Required ΔV components in active vehicle local vertical coordinates.
		Accept Rcd ΔV (lcl vert) PRO Reject Key V25E Load desired ΔV (lcl vert)		To modify ΔV (local vertical) to correct for out of planeness, key V90E (R36). Use data obtained from R36 to determine desired ΔV (local vertical).

(P35/P75) TRANSFER PHASE MIDCOURSE

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	3	FL V06 N59		2,140	
		ΔV 1, 2, 3 (LOS)	XXXX.X FPS		Required impulse ΔV components in an orthogonal coordinate system oriented along CSM to LM LOS (P35) or along LM to CSM LOS (P75). (For complete definition refer to GSOP section 5.4.2.3 of R577.)
		Rcd ΔV (LOS PRO			To obtain active vehicle central angle, key V06 N52.
	4	FL V16 N45			
		Mrks	XXBXX MKS		Number of marks processed by R22. Two most significant digits display VHF ranging marks. Two least significant digits display optics marks [either SXT or backup optics (COAS) marks].
		TF GETI (TPM)	XXBXX MIN-SEC		Time from ignition (update at 1-second intervals). Max reading is 59B59; -, before; +, after. GETI (TPM) recomputed as Tnow +A (+B for P75) for each recycle and again when final pass selected (PRO). Value of A (B for P75), stored in erasable memory, may be changed by using procedure 4.8.1.11, by P27 update, or by prelaunch erasable load.
		MGA	-0000X		-00001 for other than final pass. -00002 for final pass (and IMU not aligned in P35).
		Or IMU ALIGNED & P35	+XXX.XX DEG		Middle gimbal angle (yaw): +XXX.XX DEG for final pass and IMU aligned (if +X axis aligned to initial thrust direction)
		To continue mrk process Key V32E Return to 3			

STA/T STEP	PROCEDURE	PANEL	REMARKS
	or To term mrk proced & do fnl pass thru prog		
CMP	PRO	2,140	
	Return to 2		
	or After fnl pass thru prog		
	PRO		
	If P75, xmit all mnvr parameters to LM		
5	FL V37		R00.
	Key XXE		

(P35/P75) TRANSFER PHASE MIDCOURSE

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.13 THRUSTING		For general G&C operating data, refer to operating notes 4.6.1.
		4.13.1 VEHICLE PREPARATION		
		(Proced not designated "req" are optional)		
	1	For orb change Obtain update from MSFN		
CMP		Gas Separator Cartridge Prep (req) Remove separator from water pistol & stow temporarily in LEB stowage bag Assure separator on food prep unit secured with bayonet locks Install outlet cap on food prep unit separator SPS & SM RCS Checks, 4.5.2.1 & 4.5.2.2 EPS DC & AC Checks, 4.5.3.3 & 4.5.3.4 Press Suit Ckt & PGA Check at 5.0 psia, 4.5.4.9 (if req) C&WS Oper Check, 4.5.5.1 CMC Self Check, 4.8.1.7 DSKY Condition Lt Check, 4.8.3.1		
		If undocked from LM Dry tunnel		If necessary, absorb water with towel. Condensed moisture in tunnel rains on crew during thrusting.
		ΔV Test & Null Bias Check, 4.7.6.1		In-flight verification of X-axis accelerometer output, ΔV indicator, SPS THRUST light, and thrust cutoff relay in EMS.
	2	For deorbit or lunar ret Deorbit or Lunar Ret Veh Prep, 4.15.1 (req)		

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.13.2 G&N THRUSTING		
	4.13.2.1 (P40) G&N SPS Thrusting		Computes preferred CSM attitude and IMU orientation for SPS thrust.
			Calculates and displays gimbal angles which would result if present IMU orientation used for thrust in preferred vehicle attitude (function of R60 computations). Crew then decides whether to thrust at present IMU orientation or to reorient IMU using P52/P54.
			Maneuvers CSM to thrust attitude (R60); controls GNCS during SPS thrust countdown, ignition, thrust, and thrust termination; and allows residual steering error trimming.
	CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2		G&C circuit breakers on all panels should be closed except as defined in Limited Use Controls, 4.6.4.
	Test C/W lamps DAP - load & activate, including ull sel, 4.8.2.1		SPS trim values should be reviewed now for use at beginning of P40 in computing preferred IMU orientation and final vehicle attitude. SPS trim values are updated during CMC-controlled burn. If a roll jet fails on during SPS thrust, an appreciable roll excursion (≈30°) may occur. PITCH-YAW DAP will continue to function properly.

(P40) G&N SPS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		WARNING Experiments must be retracted prior to SPS thrust. Prevents poss boom or track structural failure. Gamma ray & mass spectrometer booms, & map camr tracks - retracted (req), 4.18.3.2, 4.18.3.4, & 4.18.3.6 If experiments S163 & S166 not complete Pan camr boost mode - on (req), 4.18.9.1, step 1 Map camr stby mode - on (req), 4.18.12.2, step 1 Prethrust prog (req), 4.12 Veh prep (req), 4.13.1		
	1	ΔV Setup, 4.7.6.2		
CMP		OPT ZERO - ZERO (verify)	122	Prevents optics drift during TVC use of OCDUs.
	2	Key V37E 00E	2	P00 updates state vector periodically.
	3	Key V37E 40E		TFI available (prior to step 10) by keying V16 N35E or V16 N40E.
		Poss PROG alarm (4.8.1.16)		R02. If no alarms at this point (after R02 exited), CMC computes initial thrust direction and initial value of VG (local vertical), computes preferred IMU orientation, and sets PFRATFLG (preferred attitude flag) and stores desired attitude for use in R60. Final attitude computed in R60, gimbals trimmed for initial thrust, and 0.5-degree deadband set in RCS DAP.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4	If VG disp desired		
CMP		Key V06 N81E VGX, Y & Z XXXX.X FPS (lcl vert at GETI)	2	Display available until average G turned on (GETI minus 30 seconds).
		(R60, Attitude Maneuver)		Maneuvers CSM to attitude stored in P40. Maneuver performed automatically by G&N, or manually with an optional final automatic G&N-controlled trim maneuver.
	5	FL V50 N18 (sel CMC - auto) R, P, Y XXX.XX DEG		Desired final gimbal angles.
		Establish tot att disp, 4.7.2.5		Both FDAIs should be selected to provide redundant displays.
CDR		Accept BMAG MODE (3) - RATE 2 CMC Att Cont - auto, 4.7.1.6	1	Prevents BMAGs from hitting stops during maneuvers.
CMP		PRO Reject Sel desired Att Cont, 4.7.1 Mnvr to thrust att ENTR - Go to 7	2	PRO initiates auto maneuver without reviewing final gimbal angles. If review desired prior to auto maneuver, reject option should be selected. If desired, attitude set control panel can then be set to final gimbal angles to provide attitude error information for completion of maneuver manually if G&N fails.
	6	Auto mnvr V06 N18 (fnl att) R, P, Y XXX.XX DEG		Angles obtained from a VECPOINT calculation. Maneuver rate is as last defined by DAP load.
CDR,CMP		Mon FDAIs If RHC used or SCS sel, go to 7	1,2	CSM began maneuver to final attitude when PRO keyed in step 5. Refer to 4.6.1.3, note 1b.

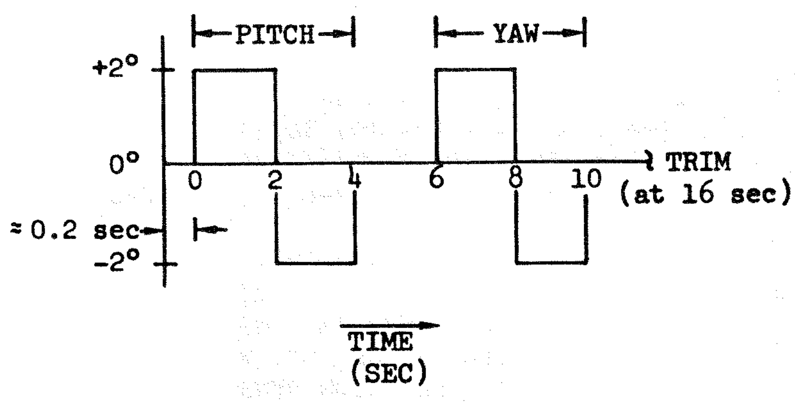
STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	7	FL V50 N18 (att trim enbl) R, P, Y XXX.XX DEG	2	Final trim maneuver should be considered essential to SPS ΔV attitudes. Display of final gimbal angles remains in registers. Final attitude trim maneuver performed after gimbal drive and trim check.
	8	Ign prep		Sets up nontime-critical switching required for thrust. If necessary for deorbit, MSFN dumps and rewinds tape recorder, and changes to HBR.
		CAUTION If either bat bus A(B) current fails to incr after cycling MN BUS TIE sws, configure bats to mn buses using cb BAT C TO BAT BUS A(B) & cb MNA(B) BAT C as necessary.	250	Assumes reconfiguration BAT C to MNA(B) for orbit change; BAT A(B) and BAT C to MNA(B) for deorbit.
LMP -10:00		MN BUS TIE BAT A/C - on (up) Verify bat bus A current incr &/or bat volt decr MN BUS TIE BAT B/C - on (up) Verify bat bus B current incr &/or bat volt decr	5 3 5 3	Verification of current increase for appropriate battery bus via DC AMPS indicator (panel 3) confirms successful operation of main bus tie motor switches. MN BUS TIE BAT A/C and B/C switches at on provide two batteries on line for orbit change if cb MNA & B BAT C (2) - open, or three batteries on line for deorbit and entry if circuit breakers closed (panel 275).
		SPS He VLV tb (both) - bp SPS He VLV (both) - AUTO	3	Barber pole indicates helium isolation valves closed.
CDR		RHC PWR DIR (both) - OFF SC CONT - CMC CMC MODE - AUTO	1	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		SCS TVC (2) - RATE CMD	1	Provides rate damped manual TVC as backup to G&N, if THC - CW. SCS auto or MTVC acceleration command optional, but less desirable backup modes.
		BMAG MODE (3) - ATT 1/RATE 2		
		RATE - LO		
		ATT DBD - MIN		
		TVC GMBL DR (2) - AUTO		
	9	Gmbl drive & trim check		PITCH and YAW GMBL caution/warning lights (panel 2) indicate overcurrent to actuator motors.
		cb SPS PITCH 1 BAT A - close (verify)	8	Remain closed from launch through first SPS thrust and closed again for each subsequent SPS thrusting.
		cb SPS YAW 1 BAT A - close (verify)		
		TVC SERVO PWR 1 - AC1/MNA	7	
		TVC SERVO PWR 2 - AC2/MNB		
		THC PWR - on (up)	1	
		RHC PWR NORM 2 - AC		Opens RHC 2 (commander's) breakout switch (dc circuits) to prevent attitude maneuvers through CMC during MTVC checks. During burn, RCS DAP disabled at SPS engine ignition (TFI = 0).
		RHC 2 - ARMED		
-05:00		GMBL MOT P1 & Y1 - START		START position is momentary. Also refer to 4.6.1.1, note 11.
		Auto switchover check		
		THC - CW		Enables MTVC and switches TVC to channel 2.
		RHC - verify no MTVC cont		
		GMBL POS ind (4) - no motion		Verifies TVC switches from channel 1 to channel 2 (which is off) when THC CW selected.
		Sec TVC check		
		GMBL MOT P2 & Y2 - START		START position is momentary.
		Confirm & set trim cont		Verifies secondary gimbal trim control.
		SPS GMBL tw (2) - + & -		
		Set to c.g. trim values		Trim values obtained from DAP Data Load (4.8.2.1) or MSFN.

(P40) G&N SPS THRUSTING

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	RHC 2 - Verify MTVC		Gimbals drive in response to RHC movement and return to set-in values when RHC neutral. Verifies control of secondary MTVC loops through RHC. Gimbals move proportional to RHC deflection since MTVC integrator not enabled until engine ignition.
	THC - neut		
	RHC PWR NORM 2 - AC/DC	1	
	Accept Complete auto att trim		Accept and reject options refer to attitude trim enable flash N50 N18 in step 7.
	BMAG MODE (3) - RATE 2		
	Align CSM in roll		
	CMC Att Cont - Auto, 4.7.1.6		
CMP	PRO	2	
	Returns to V06 N18 disp of 6		Does not imply that any previous checks need be repeated for each trim enable.
	Reject Sel desired Att Cont, 4.7.1		
	Verify/mnvr to thrust att		
	(V62E for tot att err disp)		
CDR	RHC PWR DIR (both) - MNA/MNB	1	Enables manual direct RCS for overriding an auto RCS roll failure during thrusting.
	MAN ATT (3) - RATE CMD		
	RATE - HI		If MTVC required, RATE - HI bypasses noise problem in SCS gyro assemblies because of thrusting vibration levels, which can cause spurious RCS roll jet firings.
	BMAG MODE (3) - ATT 1/RATE 2		
	or If RATE 1 ΔV planned BMAG MODE PITCH - RATE 1 BMAG MODE YAW - RATE 1		RATE 1 ΔV should be used for burns where angular change >15° or if gyro assembly 2 failed.
	or BMAG MODE (in axis) - RATE 1		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		Align GDC to IMU if necessary, 4.8.4.6		DSKY display option recommended because of its availability - only need to set ATT SET thumbwheels to DSKY values and defer alignment until just prior to thrust.
CMP		Check boresight star ENTR (exit R60)	 2	
	10	FL V50 N25 00204 (CMC GMBL drive test)		Manual drive, trim and MTVC check accomplished before CMC gimbal drive test enabled (PRO keyed).
		Accept PRO Mon GMBL drive seq		



STA/T	STEP	PROCEDURE	PANEL	REMARKS
		Reject ENTR GMBLs drive to trim position (after 4 sec)		If gimbal test sequence not desired, gimbals drive to trim 4 seconds after ENTR keyed.
	11	V06 N40 TF GETI XXBXX MIN-SEC VG XXXX.X FPS ΔV (accum) XXXX.X FPS		TF GETI max reading is 59B59. Sign minus before nominal GETI, plus after. Event Timer will not agree with R1 if GETI was slipped.

(P40) G&N SPS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	12	2-min countdown		
-02:00		Report TF GETI = 2 min		
		FDAI SCALE - 5/5	1	
		ΔV THRUST A(B) - NORM		Guarded.
		THC - ARMED		
CDR,CMP		RHC (both) - ARMED		
		(R41, State Vector Integration)		
-00:40				
CMP		If PROG lt - on, CMC slipped TIG DSKY R1 continues count to former TIG	2	May illuminate between TIG -42.5 and -35 seconds. TIG slipped delta amount as required by CMC to complete state vector integration.
		DSKY clears at new TIG -35 sec		
		COMP ACTY lt - out (exit R41)		
-00:35		DSKY clears		
-00:30		V06 N40 (ave G on)		Static display, with COMP ACTY lt flash every 2 seconds.
		Check ΔV (accum) for PIPA bias R3 ≤0002.0 FPS		G&N controlled burns unreliable if R3 >0002.0 FPS.
		If orb change		
LMP		UP TLM CMD - RSET then NORM	3	
		PCM BIT RATE - HI		
		TAPE RCDR FWD - FWD		
CDR		EMS MODE - NORM	1	4.6.1.1, note 9.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR -00:29 to -00:06	Perform ull if req		No ullage required if sump tanks full. CSM/LM or CSM 2 or 4 jet ullage times defined in SNA-8-D-027 CSM Data Book, Vol I. Retain ullage for ≈1 second after ignition. Exact velocity change not critical - only a steady ullage to settle SPS propellants.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx No ull DIR ULL pb - push, hold RHC - cont att xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	1	Direct ullage inhibits pitch and yaw auto RCS. Maintain attitude within deadband limits.
-00:05 CMP 13	FL V99 N40 (eng enbl) TF GETI XXBXX MIN-SEC VG XXXX.X FPS ΔV (accum) XXXX.X FPS	2	CMC changes V06 to V99, but retains previous display in registers. Do not exercise extended verb or monitor displays for extended periods during TVC; these displays can override a FL V97 N40 (low thrust) display. Override indicates CMC thinks engine off, steering stopped (including cutoff computations), and attitude hold established.
	Accept PRO Go to 14 Reject ENTR, go to 16 as req & 17 Man trim with RCS		If ENTR option selected, post SPS burn switching in step 16 must be accomplished.
	or V34E FL V37 Key XXE		If average G on, R00 turns off average G, zeros rendezvous mark and VHF ranging mark counters. Otherwise counters not zeroed. R00 also sets or resets RNDZ, TRACK, and UPDATE flags, depending on which programs in progress or called.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR 00:00	14	Ign SPS THRUST lt - on	1	If LM off, CMC will not accept V46 or V48 during TVC. If LM on, CMC will accept V46 as cue for low bandwidth mode (decreases control required response because of off-nominal bending moments).
CMP		V06 N40 TFC XXBXX MIN-SEC	2	Time from engine cutoff. Sign (-) before cutoff, (+) thereafter. TFC display discontinuous for 4 to 5 seconds after ignition.
		VG (decr) XXXX.X FPS ΔV accum (incr) XXXX.X FPS		
CDR		ΔV ind - decr	1	
CMP		Poss PROG alarm Key V05 N09E (to verify alarm) 01407 (VG incr)	2	
IGN+1 sec CDR		Discontinue ull		RCS X-axis translation discontinued by program 2 seconds after engine-on command. RCS DAP disabled at ignition.
IGN+2 to 5 sec		ΔV THRUST (2) - NORM (if desired)	1	Guarded. For dual bank operation.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx If no ign or premature shutdown		Engine restart should not be attempted within 5 seconds from initial ignition - avoids undesirable helium pressure excursions.
		Continue ull ΔV THRUST (2) - NORM Recycle 14		Guarded.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	or If FL V97 N40 (R40) PRO - If thrust back on	2	Thrust failure routine (R40) called if CMC detects thrust failure during non-impulsive thrusting period. If thrust decreases to some low level, VG and ΔV displays continue changing. If thrust actually terminates prematurely, VG and ΔV displays become static.
CDR	or ΔV THRUST (2) - NORM Reorient to thrust att	1	
CMP	ENTR - Recycle to 13	2	If ENTR response to FL V97 N40, R1 (TFC) set to 59B59.
	or Key V34E FL V37 Key XXE		Terminates P40 and R40.
	or Sel SCS option		
CDR	or Discontinue ull SC CONT - SCS ΔV THRUST (2) - NORM SCS TVC (2) - AUTO	1	SCS ΔV option selected to bypass as many failure modes as possible and provide minimum engine delay. Depending on duration of burn prior to failure, a motion transient could result if c.g. shifted significantly from GMBL thumbwheel values.
	Init ull THRUST ON pb - push		Ullage and THRUST ON pushbutton required to satisfy SCS logic if SPS THRUST switch not at DIR ON.
	or SPS THRUST - DIR ON		Lever lock.
IGN+1 sec	Discontinue ull		
	or Term mnvr		
	x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	15	Orb change SPS mon		
CDR		Pc ind - 95-105 psia	1	65 to 125 percent green range on indicator corresponds to psia. Normal Pc range 95-105 psia.
LMP		SPS INJ VLV ind (2 or 4) - OPEN	3	All four injector valves open for dual-bank operation.
		SPS He VLV tb (both) - gray		Gray indicates helium isolation valves open.
		SPS FUEL & OXID PRESS ind (2) - 170-195 psia		
		SPS OXID UNBAL ind - mon		Prior to crossover, maintain unbalance near value at which indicator first stabilizes after burn initiation. After crossover, maintain unbalance near zero.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		SPS OXID UNBAL ind erratic, pegged or failed stationary PUG MODE - AUX		Selects auxiliary PUGS for SPS OXID UNBAL indication.
		SPS OXID UNBAL ind erratic, pegged or failed stationary in prim & aux modes PUG MODE - NORM		
		SPS FUEL & OXID QTY ind (2) - mon		OXID FLOW VLV INCR switch controls oxid/fuel mixture ratio to maintain SPS OXID QTY indicator within ± 0.4 percent of SPS FUEL QTY indicator.
		SPS FUEL or OXID QTY ind erratic, pegged or failed stationary PUG MODE - AUX		
		SPS FUEL or OXID QTY ind erratic, pegged or failed stationary in prim & aux modes PUG MODE - NORM		Probable loss of PUGS data.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	OXID FLOW VLV INCR - as req SPS OXID VLV tb - verify	3	Switch position determined by SPS oxidizer unbalance. Continue monitoring SPS OXID UNBAL indicator.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx No SPS OXID VLV tb response during flow adj OXID FLOW VLV INCR - NORM Wait 6 sec OXID FLOW VLV PRIM - SEC OXID FLOW VLV INCR - as req OXID FLOW VLV tb - verify		Continue monitoring SPS OXID UNBAL indicator and control oxidizer flow with OXID FLOW VLV PRIM switch in SEC position until thrusting completed.
	No SPS OXID VLV tb response during flow adj in prim & sec modes		Probable SPS OXID VLV talkback failure.
	CAUTION Do not use sec oxid flow vlv with prim vlv functioning properly. Failure of sec vlv could result in loss of prplnt mgmt capability.		
	OXID FLOW VLV INCR - NORM Wait 6 sec OXID FLOW VLV PRIM - PRIM OXID FLOW VLV INCR - as req xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		SPS OXID UNBAL indicator trend may be used to confirm valve position.

(P40) G&N SPS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		CAUTION		
CDR		If noncritical burn & ΔP >20 psi ΔV THRUST (2) - OFF	1	ΔP between fuel and oxidizer should not exceed 20 psi during burn or degraded performance, rough combustion, and/or engine failure may result.
	16	Deorbit SPS mon		SPS OXID unbalance indicator erratic for about 25 seconds after ignition.
		Pc ind - 95-105 psia		65 to 125 percent green range on indicator corresponds to psia. Normal Pc range 95-105 psia.
LMP		SPS INJ VLV ind (4) - OPEN SPS He VLV tb (both) - gray SPS FUEL & OXID PRESS ind (2) - 170-195 psia	3	All four injector valves open for dual-bank operation. Gray indicates helium isolation valves open.
CDR or CMP	17	FDAI - mon err & rates	1,2	Monitoring for possible required MTVC takeover.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR		MTVC takeover THC - CW Maintain att cont man		
		or ΔV THRUST (2) - OFF	1	Guarded.
		Damp rates to IMU ball or out window Reorient & hold thrust att THC - CW		
		ΔV THRUST A(B) - NORM		Guarded.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		Init ull THRUST ON pb - push	1	Ullage and THRUST ON pushbutton required to satisfy SCS logic if SPS THRUST switch not at DIR ON.
		or SPS THRUST - DIR ON		Lever lock.
		Fly MTVC (RATE CMD)		
IGN+2 to 5 sec		ΔV THRUST B(A) - NORM (if desired)		Guarded. For dual bank operation.
		Init ull THRUST ON pb - push		Ullage and THRUST ON pushbutton required to satisfy SCS logic for second bank operation if SPS THRUST switch not at DIR ON.
		or SPS THRUST - DIR ON		Lever lock.
		or Term mnvr xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx Roll att cont failure MAN ATT ROLL - ACCEL CMD		ACCEL CMD position inhibits CMC roll commands and allows acceleration control of RCS auto coils with RHC.
		or AUTO RCS ROLL (8) - OFF Use dir cont xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	8	
	18	Mon SPS eng cutoff SPS THRUST lt - out	1	

STA/T STEP	PROCEDURE		PANEL	REMARKS
CMP	FL V16 N40 (eng cutoff)		2	
	TFC (static at 2.5 sec from cutoff)	XXBXX MIN-SEC		Time from cutoff. At cutoff +2.5 seconds, CMC sets wide deadband in RCS DAP. Then CMC switches from TVC DAP to RCS DAP at cutoff +3.1 seconds.
	VG	XXXX.X FPS		
	ΔV (accum)	XXXX.X FPS		
CDR	EVNT TMR ind - 59:59 (-) thrust duration		1	Timer normally counts down from 59:59.
C/O+1 sec	ΔV THRUST (2) - OFF			Guarded.
	SPS THRUST - NORM (verify)			Lever lock.
	Report eng off			
	Pc = 0			
LMP	SPS INJ VLV ind (4) - CLOSE		3	
	SPS He VLV tb (both) - bp			Barber pole indicates helium isolation valves closed.
C/O +2.5 sec				
CDR	GMBL POS ind (4) - servo null		1	CMC removes TVC enable discrete (C/O indicated by TFC sign change and VG → 0).
	For postorbit change free drift			
	BMAG MODE (3) - RATE 2			
	CMC MODE - FREE			
	GMBL MOT P2 & Y2 - OFF			4.6.1.1, note 11.
	GMBL MOT P1 & Y1 - OFF			
	If MTVC			
	THC - neut			To prevent possible reignition (if G&N thrust-on command still present), ΔV THRUST switches must be OFF prior to THC - neutral.
	TVC SERVO PWR (both) - OFF		7	
	If orb change			
	cb SPS PITCH 1 BAT A - open		8	
	cb SPS YAW 1 BAT A - open			

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If deorbit		
CDR		cb SPS PITCH (both) - open	8	
		cb SPS YAW (both) - open		
		EMS MODE - STBY	1	4.6.1.1, note 9.
LMP		If orb change		
		PCM BIT RATE - LO	3	
CDR		Rcd ΔV ind	1	
CMP		PRO	2	CMC sets minimum deadband in RCS DAP.
	19	FL V16 N85 (VG vctr compnt)		Velocity to be gained resolved along CSM X, Y, and Z control axes (updated each computation cycle).
		VGX, Y, Z (cont) XXXX.X FPS		
		If VG compnt to be nulled		Optional. All AUTO RCS switches must be on for nulling residuals in 3 axis.
CDR		CMC MODE - AUTO or HOLD	1	
		RHC/THC - null out VG compnt		
		THC - neut, LOCKED		
		If orb change		
		RHC - LOCKED		
LMP		If deorbit		
		TAPE RCDR FWD - off (ctr)	3	
		If R30 desired		
CMP		Key V82E	2	
		Go to 20		
		To term P40		
		PRO		
		Go to 21		CMC sets last specified R03 deadband in RCS DAP.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R30, Orbital Parameter Display)		
CMP	20	FL V16 N44 Ha XXXX.X NM Hp XXXX.X NM	2	Altitudes above launch pad radius (earth orbit) or lunar radius at most recently defined lunar landing site (lunar orbit). Parameter calculations yield reasonable results if vehicle close to earth or moon.
		TFF XXBXX MIN-SEC		Time of free fall to 49.4 NM (300,000 feet) above launch pad radius (earth orbit) or 5.8 NM (35,000 feet) above lunar radius at most recently defined lunar landing site (lunar orbit).
		If Hp >49.4 NM/5.8 NM R3 = -59B59		If TFF = -59B59, time from perigee or perilune available via N32E.
		PRO (exit R30) Return to 19		
	21	FL V37		If average G on, R00 turns off average G, and zeros rendezvous and VHF ranging mark counters. Otherwise counters not zeroed. R00 also sets or resets RNDZ, TRACK, and UPDATE flags, depending on which programs in progress or called. Under certain conditions, R00 may recycle into P20.
		If orb change Key XXE Set conts after tailoff		
LMP		MN BUS TIE (2) - OFF	5	Monitor main bus voltage for maximum allowable (31 vdc) during power down sequence.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	If MN BUS TIE fail prior to thrust		
LMP	Leave MN BUS TIE BAT B/C(A/C) - on (up)	5	Circuit breakers used to reconfigure for subsequent bat bus operation and battery charging procedures in place of opening (known) good main bus tie motor switches.
	Go to EPS SSR-2, BAT BUS A(B) reconfig for subsequent mn bus ties		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CMP	Rcd burn data		Recorded burn data should include ΔV accomplished and SPS propellant quantity remaining.
CDR	EMS FUNC - OFF	1	
	THC PWR - OFF		
	RHC PWR DIR (both) - OFF		
	If pan & map camr in stby mode		
LMP	PAN CAMR PWR - OFF	230	
	MAP CAMR ON - OFF		
CMP	SM/AC PWR - OFF	181	
	Chg bats, 4.5.3.5		
	If last MCC & lunar return, or TLI abort		
	Go to Deorbit or Lunar Return Veh Prep, 4.15.1, prior to entry		
	or If deorbit		
	Rcd burn data		Recorded burn data should include ΔV accomplished.
	Key 61E	2	
	Go to CM/SM Sep, 4.15.2		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.13.2.2 (P41) G&N SM-RCS Thrusting		Computes preferred CSM attitude and preferred IMU orientation for RCS thrust, and maneuvers CSM to thrust attitude (R60).
		CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2		G&C circuit breakers on all panels should be closed except as defined in Limited Use Controls, 4.6.4.
		Test C/W lamps Prethrust prog (req), 4.12 Veh Prep (req), 4.13.1 DAP - Load & Activate, 4.8.2.1		
CDR	1	Set EVNT TMR to read 00:00 at GETI	1	
CMP	2	Key V37E 00E	2	P00 updates state vector periodically.
	3	Key V37E 41E		TFI available (prior to step 12) by keying V16 N35E or V16 N40E.
		Poss PROG alarm (4.8.1.16)		R02. If no alarms at this point (after R02 exited), CMC computes initial thrust direction and initial value of VG (local vertical), computes preferred IMU orientation, sets PFRATFLG (preferred attitude flag) and stores desired attitude for use in R60. Final attitude computed in R60 and 0.5-degree deadband set in RCS DAP.
	4	If VG disp desired Key V06 N81E VGX, Y, Z XXXX.X FPS (Lcl vert at GETI)		Display available until average G turned on (GETI minus 30 seconds).

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R60, Attitude Maneuver)		Maneuvers CSM to attitude stored in P41. Maneuver performed automatically by G&N, or manually with optional final automatic G&N controlled trim maneuver.
CMP	5	FL V50 N18 (sel CMC - auto) R, P, Y XXX.XX DEG	2	Desired final gimbal angles.
		Establish Tot Att disp, 4.7.2.5		Both FDAIs should be selected to provide redundant displays.
CDR		Accept BMAG MODE (3) - RATE 2 CMC Att Cont - auto, 4.7.1.6	1	Prevents BMAGs from hitting stops during maneuvers.
CMP		PRO	2	Initiates auto maneuver without a review of final gimbal angles.
CDR		Reject Sel desired Att Cont, 4.7.1 Mnvr to thrust att		
CMP		ENTR, go to 8		
	6	Auto mnvr V06 N18 (fnl att) R, P, Y XXX.XX DEG		
CDR,CMP		Mon FDAIs If RHC used or SCS sel, go to 7	1,2	CSM began maneuver to final attitude when PRO keyed in step 5. ICDU drives to achieve final gimbal angles. Refer to 4.6.1.3, note 1b.
CMP	7	FL V50 N18 (att trim enbl) R, P, Y XXX.XX DEG	2	Step should be completed prior to TIG -2 minutes. Display of final gimbal angles in registers.
CDR		Accept BMAG MODE (3) - RATE 2 CMC Att Cont - auto, 4.7.1.6	1	

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	PRO Returns to V06 N18 disp of 6	2	Does not imply that any previous checks need be repeated for each trim enable.
CDR	Reject Sel desired Att Cont, 4.7.1		
CMP	Verify/mnvr to thrust att (V62E for tot att err disp)		All RCS channels required for 3-axis translation.
CDR	MAN ATT (3) - RATE CMD BMAG MODE (3) - ATT 1/RATE 2 Align GDC to IMU if necessary, 4.8.4.6	1	DSKY display option recommended because of its availability - only need to set ATT SET thumbwheels to DSKY values and defer alignment until just prior to thrust.
CMP	ENTR (exit R60)	2	
8	Mon VG disp V06 N85 (VG vctr compnts) VGX, Y, Z (cont) XXXX.X FPS		Components resolved along CSM axes, and updated at 1-second intervals.
-05:00 9	Ign prep		Sets up nontime-critical switching required for thrust.
CDR	Check boresight star For X axis thrust THC PWR - on (up) If orb change ΔV Test & Null Bias Check, 4.7.6.1	1	For deorbit thrust, check accomplished during EMS Entry Test, 4.15.1.3, if desired.
	ΔV Setup, 4.7.6.2		Set to ΔV obtained from charts, P30, and/or MSFN.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R41, State Vector Integration)		
-00:40				
CMP	10	If PROG lt - on, CMC slipped TIG	2	May illuminate between TIG -42.5 and -35 seconds.
		DSKY R1 continues count to former TIG		TIG slipped delta amount as required by CMC to
		DSKY clears at new TIG -35 sec		complete state vector integration.
		COMP ACTY lt - out (exit R41)		
-00:35		DSKY clears		
-00:30				
	11	V16 N85 (ave G on)		Static display with COMP ACTY light flash every 2 seconds.
-00:25				
CDR		THC - ARMED		
CDR,CMP		RHC (both) - ARMED		
CDR		LIM CYCLE - OFF	1	For SCS translations.
		If deorbit		
LMP		TAPE RCDR FWD - FWD	3	
CDR		EMS MODE - NORM	1	4.6.1.1, note 9.
00:00				
	12	RCS thrust		
CMP		FL V16 N85 (requests null VG)	2	Event Timer not valid if GETI slipped.
		VGX, Y, Z (cont) XXXX.X FPS		
CDR		Man null VG		Command manual translations and rotations to null VG components.
		If R30 desired		
CMP		Key V82E		
		Go to 13		
		To term P41		
		PRO		
		Go to 14		CMC sets last specified R03 deadband in RCS DAP.

(P41) G&N SM RCS THRUSTING

STA/T	STEP	PROCEDURE		PANEL	REMARKS
		(R30, Orbital Parameter Display)			R30 displays automatically updated at 2-second intervals if called because average G still on.
CMP	13	FL V16 N44		2	
		Ha	XXXX.X NM		Altitudes above launch pad radius (earth orbit) or lunar radius at most recently defined lunar landing site (lunar orbit).
		Hp	XXXX.X NM		
		TFF	XXBXX MIN-SEC		Time of free fall to 49.4 NM (300,000 feet) above launch pad radius (earth orbit) or 5.8 NM (35,000 feet) above lunar radius at most recently defined lunar landing site (lunar orbit).
		If Hp >49.4 NM/5.8 NM R3 = -59B59 PRO (exit R30) Return to 12			If TFF = -59B59, time from perigee or perilune available via N32E.
	14	Thrust complete			
CDR		EMS MODE - STBY		1	4.6.1.1, note 9.
		Rcd ΔV ind			
		If orb change EMS FUNC - OFF THC PWR - OFF			
CDR,CMP		RHC (both) - LOCKED			
		If deorbit			
LMP		TAPE RCDR FWD - off (ctr)		3	
CDR		THC - neut, LOCKED			
CMP	15	FL V37		2	If average G on, R00 turns off average G, and zeros rendezvous and VHF ranging mark counters. Otherwise counters not zeroed. R00 also sets or resets, RNDZ, TRACK, and UPDATE flags, depending on which programs in progress or called. Under certain conditions, R00 may recycle into P20.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If orb change		
CMP		Key XXE	2	
		If last MCC & lunar return, or TLI abort		
		Go to Deorbit or Lunar Return Veh Prep, 4.15.1, prior to entry		
	or	If deorbit		
		Key 61E (if desired)		P61 may be bypassed if hybrid or SCS deorbit.
		Go to CM/SM Sep, 4.15.2		

(P41) G&N SM RCS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.13.2.3 G&N Hybrid Deorbit Thrusting		Computes preferred CSM attitude and preferred IMU orientation for RCS thrusting maneuver. Maneuvers CSM to thrusting attitude (R60), and provides sufficient displays for cutoff of both SM RCS burn followed by CM RCS deorbit burn.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2		G&C circuit breakers on all panels should be closed except as defined in Limited Use Controls, 4.6.4.
		Test C/W lts Prethrust prog (req), 4.12 Veh Prep (req), 4.13.1 DAP - Load & Activate, 4.8.2.1		
CDR	1	**Set EVNT TMR to read 00:00 at GETI**	1	
CMP	2	Key V37E 41E	2	
		Poss PROG alarm (4.8.1.16)		R02. If no alarms at this point (after R02 exited), CMC computes initial thrust direction and initial value of VG (local vertical), computes preferred IMU orientation, sets PFRATFLG (preferred attitude flag), and stores desired attitude for use in R60. Final attitude computed in R60 and 0.5-degree deadband set in RCS DAP.
	3	If VG disp desired Key V06 N81E VGX, Y, Z XXXX.X FPS (lcl vert at GETI)		Display available until average G turned on (GETI minus 30 seconds).

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R60, Attitude Maneuver)		Maneuvers CSM to attitude stored in P41. Maneuver performed automatically by G&N, or manually with an optional final automatic G&N controlled trim maneuver.
CMP	4	FL V50 N18 (sel CMC - auto) R, P, Y XXX.XX DEG	2	
		Establish Tot Att disp, 4.7.2.5		Both FDAIs should be selected to provide redundant displays.
CDR		Accept BMAG MODE (3) - RATE 2 CMC Att Cont - auto, 4.7.1.6	1	Prevents BMAGs from hitting stops during maneuvers.
CMP		PRO	2	Initiates auto maneuver without review of final gimbal angles.
CDR		Reject Sel desired Att Cont, 4.7.1		
CMP		ENTR, go to 7		
	5	Auto mnvr V06 N18 (fnl att) R, P, Y XXX.XX DEG		
CDR,CMP		Mon FDAIs	1,2	CSM began maneuver to final attitude when PRO keyed in step 4. ICDU drives to achieve final gimbal angles. Refer to 4.6.1.3, note 1b.
		If RHC used or SCS sel, go to 6		
CMP	6	FL V50 N18 (att trim enbl) R, P, Y XXX.XX DEG	2	Step should be completed prior to TIG -2 minutes. Display of final gimbal angles in registers.
CDR		Accept BMAG MODE (3) - RATE 2 CMC Att Cont - auto, 4.7.1.6	1	
CMP		PRO, return to 5	2	

G&N HYBRID DEORBIT THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Reject: Sel desired Att Cont, 4.7.1 Verify/mnvr to thrust att (V62E for tot att err disp)		
CDR		MAN ATT (3) - RATE CMD BMAG MODE (3) - ATT 1/RATE 2	1	DSKY display option recommended because of its availability - only need to set ATT SET thumbwheels to DSKY values and defer alignment until just prior to thrust.
CMP		ENTR (exit R60)	2	
	7	Mon VG disp V06 N85 (VG vctr compnts) VGX, Y, Z (cont) XXXX.X FPS		Components resolved along CSM axes and updated at 1-second intervals.
LMP	8	Configure & preload bats		Prepares for battery preloading prior to CM/SM separation and verifies batteries transferred to main buses.
		CAUTION If either bat bus A(B) current fails to incr after cycling MN BUS TIE sws, configure bats to mn buses using cb BAT C TO BAT BUS A(B).	250	Assumes reconfiguration BAT A(B) and BAT C to MNA(B).
-10:00		MN BUS TIE BAT A/C - on (up)	5	
		Verify bat bus A current incr &/or bat volt decr	3	Verification of current increase for appropriate battery bus via DC AMPS indicator (panel 3) confirms successful operation of main bus tie motor switches. MN BUS TIE BAT A/C and B/C switches at on provide two batteries on line if circuit breaker MNA & B BAT C (2) - open, or three batteries on line for deorbit and entry if circuit breakers closed (panel 275).
		MN BUS TIE BAT B/C - on (up)	5	
		Verify bat bus B current incr &/or bat volt decr	3	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
-05:00				
CDR	9	Ign prep THC PWR - on (up)	1	Sets up nontime-critical switching required for thrusting.
		ΔV Setup, 4.7.6.2		Set to ΔV obtained from charts, P30, and/or MSFN.
		(R41, State Vector Integration)		
-00:40				
CMP	10	If PROG lt - on, CMC slipped TIG DSKY R1 continues counting to former TIG DSKY clears at new TIG -35 sec COMP ACTY lt - out (exit R41)	2	May illuminate between TIG -42.5 and -35 seconds. TIG slipped delta amount as required by CMC to complete state vector integration.
-00:35		DSKY clears		
-00:30				
	11	V16 N85 (ave G on)		Static display with COMP ACTY light flashing every 2 seconds.
-00:25				
CDR,CMP		RHC (both) - ARMED		
CDR		THC - ARMED		
		LIM CYCLE - OFF	1	For SCS translations.
LMP		TAPE RCDR FWD - FWD	3	
CDR		EMS MODE - NORM	1	4.6.1.1, note 9.
00:00				
CMP	12	SM RCS thrust FL V16 N85 (request null VG) VGX, Y, Z (cont) XXXX.X FPS	2	Event Timer not valid if GETI slipped.
CDR		Man null VG Mon DSKY, ΔV ind, & EVNT TMR	1,2	Command manual translation and rotation to null VG components.

G&N HYBRID DEORBIT THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Crew options V83 - R, R dot, θ V82 - Ha, Hp, TFF	2	
	13	SM RCS thrust complete		
CDR		EMS MODE - STBY	1	4.6.1.1, note 9.
CMP		Rcd DSKY, ΔV ind, & EVNT TMR values	1,2	
CDR		Reset EVNT TMR	1	
		THC - neut, LOCKED		
	14	Sel SCS Att Cont mode, 4.7.1		Separation follows immediately, preventing proper G&N DAP operation until entry DAP selected in P62.
	15	Perform Sep proced, 4.15.2		Separation at SM deorbit attitude saves time. Only one minute allowed between burns.
	16	Verify/mnvr to CM RCS deorbit att R ___°, P ___°, Y ___°		Both CM RCS systems should be enabled. CM RCS deorbit portion completed with +X axis ≈70° below velocity vector (apex down and forward); ≈110° +pitch maneuver from heads down, BEF, SM RCS portion of deorbit.
		MAN ATT YAW, ROLL - RATE CMD MAN ATT PITCH - ACCEL CMD RATE - HI ATT DBD - MIN		
CDR,CMP		RHC (both) - ARMED		
CDR		FDAI SCALE - 5/5		
CMP	17	Key V82E FL V16 N44	2	
		Ha XXXX.X NM Hp XXXX.X NM		Altitudes above launch pad radius.
		TFF XXBXX MIN-SEC		Time of free fall to 49.4 NM (300,000 feet) above launch pad radius.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	18	EVNT TMR ind - SM RCS C/O +1 min EMS MODE - NORM	1	One minute after SM RCS cutoff, start CM RCS burn. 4.6.1.1, note 9.
CMP CDR		RHC 1 - contin -pitch RHC 2 - pulse to maintain att in pitch axis Mon FDAI		Negative pitch jets have ≈25 to 30 percent less authority than positive jets because of jet location and thrust direction relative to CM c.g.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx If only 1 RHC Pulse RHC + & - ≈5° pitch from pitch retro att, maintaining rates <3°/sec xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CMP	19	Mon Hp & TFF on DSKY	2	Monitor Event Timer for duration of thrust no greater than 02:10 for either single or dual system. Conserve CM RCS propellant reserves, 30 pounds each system for entry. ΔV indicator cutoff cue must be adjusted to account for EMS sensing axis (along X) being reversed from SM RCS burn and biased off ≈70° from CM RCS velocity vector. (ΔVems = ΔVcm Cos 70°).
	20	PRO FL V16 N85 VGX, Y, Z (cont) XXXX.X FPS		
	21	Thrust complete, ΔV ind = _____ or EVNT TMR = _____	1	
		PRO	2	
CDR		MAN ATT (3) - RATE CMD	1	
		Rcd ΔV ind, DSKY, EVNT TMR	1,2	

G&N HYBRID DEORBIT THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP		TAPE RCDR FWD - off (ctr)	3	
CDR		ATT DBD - MAX	1	
CMP	22	FL V37	2	
CDR		EMS MODE - STBY	1	4.6.1.1, note 9.
CDR,CMP		RHC (both) - LOCKED		
	23	Sel Att Cont mode, 4.7.1 Mnvr to entry att R ___°, P ___°, Y ___°		
	24	Set up for CM RCS sys 1		
CDR		AUTO RCS A/C ROLL (4) - OFF AUTO RCS CM 1 (6) - MNA or MNB AUTO RCS CM 2 (6) - OFF	8	Electrically isolates system 2 for entry. If problem develops in system 1, disable affected channel and use direct RCS control.
	25	Go to G&N Entry, 4.15.3		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.13.3 SCS THRUSTING		
		4.13.3.1 <u>SCS SPS Thrusting</u>		
		CMC - on (desired), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2		CMC and ISS on, and orientation known, necessary for P47 monitor. G&C circuit breakers on all panels should be closed except as defined in Limited Use Controls, 4.6.4.
		<u>WARNING</u> Experiments must be retracted prior to SPS thrust. Prevents poss boom or track structural failure.		
		Gamma ray & mass spectrometer booms, & map camr tracks - retracted (req), 4.18.3.2, 4.18.3.4, & 4.18.3.6 If experiments S163 & S166 not complete Pan camr boost mode - on (req), 4.18.9.1, step 1 Map camr stby mode - on (req), 4.18.12.2, step 1 Veh Prep (req), 4.13.1		
	1	ΔV Setup, 4.7.6.2		
CMP	2	Key V37E 00E	2	P00 updates state vector periodically.
	3	Establish Tot Att disp, 4.7.2.5		To obtain telemetry on BMAG attitude error, FDAI SEL switch must be in 1 or 2 position (with SCS displays).
	4	SCS Att Mnvr to thrust att, 4.8.4.5		

SCS SPS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	5	Establish SCS Att Hold, 4.7.1.4		Limit cycle, maximum deadband and low rate should be selected for propellant conservation.
CMP		Check boresight star	2	
	6	Ign prep		Sets up nontime-critical switching required for thrusting.
LMP		SPS He VLV tb (both) - bp SPS He VLV (both) - AUTO	3	Barber pole indicates helium isolation valves closed.
		CAUTION If either bat bus A(B) current fails to incr after cycling MN BUS TIE sws, configure bats to mn buses using cb BAT C TO BAT BUS A(B) & cb MNA(B) BAT C as necessary.	250	Assumes reconfiguration BAT C to MNA(B) for orbit change; BAT A(B) and BAT C to MNA(B) for deorbit.
LMP -10:00		MN BUS TIE BAT A/C - on (up) Verify bat bus A current incr &/or bat voltage decr MN BUS TIE BAT B/C - on (up) Verify bat bus B current incr &/or bat voltage decr	5 3 5 3	Verification of current increase for appropriate battery bus via DC AMPS indicator (panel 3) confirms successful operation of main bus tie motor switches. MN BUS TIE BAT A/C and B/C switches at on provide two batteries on line for orbit change if circuit breakers MNA & B BAT C (2) - open, or three batteries on line for deorbit and entry if circuit breakers closed (panel 275).
CDR		RHC PWR DIR (both) - OFF SCS TVC (2) - AUTO TVC GMBL DR (2) - AUTO ΔV CG - LM/CSM or CSM Establish Ull Sel, 4.6.1	1	
CMP	7	If P47 for thrust mon Key V37E 47E	2	G&N monitoring highly desirable but not required. Refer to 4.8.1.6 for P47 description.
		Poss PROG alarm (4.8.1.16)		R02.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		FL V16 N83	2	
		ΔVX, Y, Z (cont) XXXX.X FPS		
		If desired		
		Key N62E		
		VI XXXXX. FPS		Inertial velocity.
		H dot XXXXX. FPS		Altitude rate.
		H pad XXXX.X NM		Altitude above pad radius (earth orbit) or landing site radius (lunar orbit).
		KEY REL (to return to N83)		
	8	Gmbl drive & trim check		PITCH and YAW GMBL caution/warning lights indicate overcurrent to actuator motors.
CDR		TVC SERVO PWR 1 - AC1/MNA	7	
		TVC SERVO PWR 2 - AC2/MNB		
		cb SPS PITCH 1 BAT A - close (verify)	8	Remain closed from launch through first SPS thrust and closed again for each subsequent SPS thrusting.
		cb SPS YAW 1 BAT A - close (verify)		
		THC PWR - on (up)	1	
		RHC PWR NORM 2 - AC		Opens RHC 2 (commander's) breakout switch dc circuits to prevent loss of attitude reference. Prevents RCS jets from firing when RHC is used for MTVC check. Normally, IGN 1 signal disables RCS pitch and yaw channels 1 second after SPS engine ignition.
		RHC 2 - ARMED		
		Prim TVC check		4.6.1.1, note 11.
-05:00		GMBL MOT P1 & Y1 - START		START position is momentary.
		Verify trim cont on ind		Gimbals drive in response to thumbwheel movement. Verifies primary gimbal trim control.
		Auto switchover check		
		THC - CW		
		RHC 2 - verify no MTVC		
		GMBL POS ind (4) - no motion		Verifies TVC control switches from channel 1 to channel 2 (which is off) when THC - CW selected.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		Sec TVC check		
CDR		GMBL MOT P2 & Y2 - START	1	START position is momentary.
		Verify trim cont		Verifies secondary gimbal trim control.
		Verify MTVC THC - neut		Gimbals drive in response to RHC movement, and return to set-in values when RHC neutral. Verifies control of secondary MTVC loops through RHC.
		SPS GMBL tw (2) - set & confirm fnl desired gmbl position		Gimbals trimmed in primary channel to thrusting values (SCS modes).
	9	RHC PWR DIR (both) - MNA/MNB		Enables manual direct RCS for overriding a roll automatic RCS failure during thrusting.
		RHC 2 - null att err		Needles can be used as error null reference during MTVC contingency takeover from automatic ΔV mode.
		ATT DBD - MIN		Set to MIN as errors nulled.
		RHC PWR NORM (both) - AC/DC		
		Check boresight star		
CMP	10	2-min countdown		
-02:00		Report TF GETI = 2 min	2	
CDR		FDAI SCALE - 5/5	1	
		ΔV THRUST A(B) - NORM		Guarded.
		THC - ARMED		
		LIM CYCLE - OFF		
		If orb change		
LMP		UP TLM CMD - RSET, then NORM	3	
		PCM BIT RATE - HI		
-00:30		TAPE RCDR FWD - FWD		
CDR		EMS MODE - NORM	1	4.6.1.1, note 9.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR -00:29 to -00:06	Perform ull (if req)		No ullage required if SPS sump tanks full. CSM/LM or CSM 2 or 4 jet ullage times defined in SNA-8-D-027 CSM Data Book, Vol I. Exact velocity change not critical - only steady ullage to settle SPS propellants.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxx No ull DIR ULL pb - push, hold	1	Direct ullage inhibits pitch and yaw auto RCS control. Attitude should be maintained manually.
	RHC 2 - cont att xxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
11 00:00	Orb change ign If ull present THRUST ON pb - push		Engine restart should not be attempted within 5 seconds from initial ignition - avoids undesirable He pressure excursions.
	If no ull present THC - +X, hold		Provides ullage discrete to SCS.
	THRUST ON pb - push SPS THRUST lt - on		
IGN+1 sec	RATE - HI		Bypasses noise problem in SCS gyro assemblies because of thrusting vibration levels and provides backup to auto selection of high rate in pitch and yaw TVC.
	Discontinue ull		
IGN +2 to 5 sec	ΔV THRUST (2) - NORM (if desired)		For dual bank operation.
	Init ull THRUST ON pb - push		Ullage and THRUST ON pushbutton required to satisfy SCS logic for second bank operation.

SCS SPS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If no ign, or premature shutdown		
CDR		ΔV THRUST (2) - NORM	1	
		Recycle 11		
		or SPS THRUST - DIR ON		Lever lock.
		Recycle 11		
		or Term mnvr		
	12	Deorbit ign		Engine restart should not be attempted within 5 seconds from initial ignition to avoid undesirable He pressure excursions.
00:00		SPS THRUST - DIR ON		
		SPS THRUST lt - on		
IGN+1 sec		RATE - HI		Bypasses noise problem in SCS gyro assemblies because of thrusting vibration levels and provides backup to automatic selection of high rate in pitch and yaw TVC.
		If no ign		
		ΔV THRUST (2) - NORM		Guarded.
		Recycle 12		
		or Term mnvr		
		Discontinue ull		
IGN +2 to 5 sec		ΔV THRUST (2) - NORM		Guarded.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	13	Orb change SPS mon		
CDR		Pc ind - 95-105 psia	1	65 to 125 percent green range on indicator corresponds to psia. Normal range 95-105 psia.
LMP		SPS INJ VLV ind (2 or 4) - OPEN	3	All four injector valves open for dual-bank operation.
		SPS He VLV tb (both) - gray		Gray indicates helium isolation valves open.
		SPS FUEL & OXID PRESS ind (2) - 170-195 psia		
		SPS OXID UNBAL ind - mon		Prior to crossover, maintain unbalance near value at which indicator first stabilizes after burn initiation. After crossover, maintain unbalance near zero.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		SPS OXID UNBAL ind erratic, pegged or failed stationary		
		PUG MODE - AUX		Selects auxiliary PUGS for SPS OXID UNBAL indication.
		SPS OXID UNBAL ind erratic, pegged or failed stationary in prim & aux modes		
		PUG MODE - NORM		
		SPS FUEL & OXID QTY ind (2) - mon		OXID FLOW VLV INCR switch controls oxid/fuel mixture ratio to maintain SPS OXID QTY indicator within ±0.4 percent of SPS FUEL QTY indicator.
		SPS FUEL or OXID QTY ind erratic, pegged or failed stationary		
		PUG MODE - AUX		
		SPS FUEL or OXID QTY ind erratic, pegged or failed stationary in prim & aux modes		
		PUG MODE - NORM		Probable loss of PUGS data.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	OXID FLOW VLV INCR - as req SPS OXID VLV tb - verify	3	Switch position determined by SPS oxidizer unbalance. Continue monitoring SPS OXID UNBAL indicator.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x x		
	No SPS OXID VLV tb response during flow adj OXID FLOW VLV INCR - NORM Wait 6 sec OXID FLOW VLV PRIM - SEC OXID FLOW VLV INCR - as req OXID FLOW VLV tb - verify		Continue monitoring SPS OXID UNBAL indicator and control oxidizer flow with OXID FLOW VLV PRIM switch in SEC position until thrusting completed.
	No SPS OXID VLV tb response during flow adj in prim & sec modes		Probable SPS OXID VLV talkback failure.
	CAUTION Do not use sec oxid flow vlv with prim vlv functioning properly. Failure of sec vlv could result in loss of prplnt management capability.		
	OXID FLOW VLV INCR - NORM Wait 6 sec OXID FLOW VLV PRIM - PRIM OXID FLOW VLV INCR - as req		SPS OXID UNBAL indicator trend may be used to confirm valve position.
	x x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		CAUTION If noncritical burn & ΔP >20 psi,		ΔP between fuel and oxidizer should not exceed 20 psi during burn or degraded performance, rough combustion and/or engine failure may result.
CDR		ΔV THRUST (2) - OFF	1	Guarded.
	14	Deorbit SPS mon		SPS OXID UNBAL indicator erratic for about 25 seconds after ignition.
LMP		Pc ind - 95-105 psia SPS INJ VLV ind (4) - OPEN SPS He VLV tb (both) - gray SPS FUEL & OXID PRESS ind (2) - 170-195 psia	3	Gray indicates helium isolation valves open.
CDR or LMP	15	FDAI - mon att err & rates	1,2	
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR		Orb change MTVC takeover Pitch & yaw err & rates abnormal ΔV THRUST (2) - OFF Damp rates to IMU ball or out window with RHC	1	Backup procedure bypasses maximum possible failure modes, thereby providing alternate means of completing burn without troubleshooting.
		If no response Use dir RCS & disable affected chan		Since a failure causing abnormal TVC and RCS attitude control is not a failed-on jet, RCS disabling should be done with MAN ATT switch to ACCEL CMD rather than AUTO RCS switches OFF, thereby providing automatic RCS control for reorientation.

SCS SPS THRUSTING

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	If rate needle(s) abnormal		
	BMAG MODE - RATE 1	1	
	Reorient to thrust att		
	THC - CW		
	ΔV THRUST A(B) - NORM		Guarded.
	Init ull		
	THRUST ON pb - push		
	or SPS THRUST - DIR ON		Lever lock.
	Fly MTVC (rate cmd)		
IGN+2 to 5 sec	ΔV THRUST B(A) - NORM (if desired)		For dual bank operation.
	Init ull		Ullage and THRUST ON pushbutton required to satisfy SCS logic for second bank operation if SPS THRUST switch not at DIR ON.
	THRUST ON pb - push		
	or SPS THRUST - DIR ON		Lever lock.
	or Term mnvr		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	Orb change roll err & rates abnormal & no roll att cont		
	MAN ATT ROLL - ACCEL CMD		
	RHC - cont roll rates		
	or AUTO RCS (16) - OFF	8	
	Cont roll using dir RCS		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR		Deorbit MTVC takeover		
		If err & rates abnormal		Backup procedure bypasses maximum possible failure modes, thereby providing an alternate means of completing burn without troubleshooting.
		ΔV THRUST (2) - OFF	1	
		Damp rates to IMU ball or out window with RHC		
		SPS THRUST - NORM		Lever lock.
		If no response		Since a failure causing abnormal TVC and RCS attitude control is not a failed-on jet, RCS disabling should be done with MAN ATT switch to ACCEL CMD rather than AUTO RCS switches - OFF, thereby providing automatic RCS control for reorientation.
		Use dir RCS & disable affected chan		
		If rate needle(s) abnormal		
		BMAG MODE - RATE 1		
		Reorient to thrust att		
		THC - CW		
		ΔV THRUST A(B) - NORM		Guarded.
		Init ull		
		SPS THRUST - DIR ON		Lever lock.
		Fly MTVC (rate cmd)		
IGN+2 to 5 sec		ΔV THRUST (2) - NORM		Guarded.
		or Term mnvr		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

SCS SPS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		Deorbit no roll att cont		
CDR		MAN ATT ROLL - ACCEL CMD	1	
		RHC - cont roll rates		
		or AUTO RCS (16) - OFF	8	
		Cont roll using dir RCS		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	16	Mon for SPS eng cutoff cue		
		ΔV ind - goes thru -0.1	1	For suspected ΔV indicator failures, utilize Event Timer to terminate SPS thrust manually. Timer normally counts down from 59:59.
		&/or EVNT TMR ind - 59:59 (-) thrust duration		
		ΔV THRUST (2) - OFF		Guarded.
		SPS THRUST - NORM		Lever lock.
		SPS THRUST lt - out		
		For postorbit change free drift		
		MAN ATT (3) - ACCEL CMD		
		Report eng cutoff		
		Pc = 0		
LMP		SPS INJ VLV ind (4) - CLOSE	3	
		SPS He VLV tb (both) - bp		Barber pole indicates helium isolation valves closed.
	17	Set cont after tailoff		
CDR		GMBL MOT P2 & Y2 - OFF	1	4.6.1.1, note 11.
		GMBL MOT P1 & Y1 - OFF		
		EMS MODE - STBY		4.6.1.1, note 9.
LMP		If orb change		
		PCM BIT RATE - LO	3	
CMP		Rcd ΔV ind	1	
CDR		TVC SERVO PWR (both) - OFF	7	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If orb change		
CDR		cb SPS PITCH 1 BAT A - open	8	
		cb SPS YAW 1 BAT A - open		
		If deorbit		
		cb SPS PITCH (both) - open		
		cb SPS YAW (both) - open		
		ATT DBD - MAX	1	
		THC - LOCKED		
		If deorbit		
LMP		TAPE RCDR FWD - off (ctr)	3	
		If orb change		
CDR,CMP		RHC (both) - LOCKED		
CDR		RHC PWR DIR (both) - OFF	1	
CMP		(To re-zero registers, V32E)	2	Provides capability to monitor another burn without going through R00.
	18	PRO (exit P47)		When P47 termination desired.
	19	FL V37		
		Key XXE		
		If deorbit		
		Go to CM/SM Sep, 4.15.2		
		If orb change		
LMP		MN BUS TIE (2) - OFF	5	
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		If MN BUS TIE fail prior to thrust		
		Leave MN BUS TIE BAT B/C(A/C) - on (up)		
		Go to EPS SSR-2 BAT BUS A(B) reconfig for subsequent mn bus ties		Circuit breakers used to reconfigure for subsequent bat bus operation and battery charging procedures in place of opening (known) good main bus tie motor switches.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		EMS FUNC - OFF	1	
		If pan & map camr in stby mode		
LMP		PAN CAMR PWR - OFF	230	
		MAP CAMR ON - OFF		
CMP		SM/AC PWR - OFF	181	
		Charge bats, 4.5.3.5		
		If last MCC & lunar return, or TLI abort		
		Go to Deorbit or Lunar Return Veh Prep, 4.15.1, prior to entry		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.13.3.2 SCS SM RCS Thrusting		
		CMC - on (desired), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2 Veh Prep (req), 4.13.1		CMC and ISS on, and orientation known, necessary for P47 monitor.
CMP	1	Key V37E 00E	2	P00 updates state vector periodically.
	2	Establish Tot Att disp, 4.7.2.5		
	3	Sel desired Att Cont, 4.7.1 Mnvr to thrust att		All RCS channels required for 3-axis thrusting.
	4	Establish SCS Att Hold, 4.7.1.4		Limit cycle, maximum deadband and low rate should be selected for propellant conservation until prior to thrusting.
-05:00				
	5	Check boresight star		
	6	For X-axis thrust		EMS can monitor only X-axis thrusting.
		If orb change ΔV Test & Null Bias Check, 4.7.6.1		For deorbit thrust, ΔV Test & Null Bias Check previously accomplished during Deorbit or Lunar Return Vehicle Preparation, 4.15.1, if desired.
		ΔV Setup, 4.7.6.2		
	7	If P47 for thrust mon Key V37E 47E		G&N monitoring highly desirable, but not required. Refer to 4.8.1.6 for P47 description.

SCS SM RCS THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Poss PROG alarm (4.8.1.16)	2	R02.
		FL V16 N83		
		ΔVX, Y, Z (cont) XXXX.X FPS		
		If desired		
		Key N62E		
		VI XXXXX. FPS		Inertial velocity.
		H dot XXXXX. FPS		Altitude rate.
		H pad XXXX.X NM		Altitude above pad radius (earth orbit) or landing site radius (lunar orbit).
		KEY REL (to return to N83)		
-00:30				
CDR, CMP	8	RHC (both) - ARMED		
CDR		THC - ARMED		
		ATT DBD - MIN	1	
		LIM CYCLE - OFF		
LMP		If deorbit		
		TAPE RCDR FWD - FWD	3	
CDR		EMS MODE - NORM	1	4.6.1.1, note 9.
00:00				
	9	Perform thrust by manually nulling ΔV ind		
	10	EMS MODE - STBY		4.6.1.1, note 9.
		Rcd ΔV compnts		
		If orb change		
		EMS FUNC - OFF		
CDR,LMP		RHC (both) - LOCKED		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		THC - neut, LOCKED		
LMP		If deorbit TAPE RCDR FWD - off (ctr)	3	
CMP		(To re-zero registers, V32E)	2	Provides capability to monitor another burn without going through R00.
	11	PRO (exit P47)		
	12	FL V37 Key XXE		R00 turns off average G.
	13	If deorbit Go to CM/SM Sep, 4.15.2		
	14	If last MCC & lunar return, or TLI abort Go to Deorbit or Lunar Return Veh Prep, 4.15.1, prior to entry		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.13.3.3 <u>SCS Hybrid Deorbit Thrusting</u>		This procedure can be utilized for a pure CM RCS deorbit by omitting steps 10 and 11.
		CMC - on (desired), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2 Veh Prep (req), 4.13.1		CMC and ISS on, and orientation known, necessary for P47 monitor.
CMP	1	Key V37E 00E	2	P00 updates state vector periodically.
	2	Establish Tot Att disp, 4.7.2.5		
	3	Sel desired Att Cont, 4.7.1 Mnvr to thrust att R_____°, P_____°, Y_____°		Thrusting attitude for SM RCS portion of hybrid burn is nominally a retrograde +X translation with heads down and BEF.
	4	Establish SCS Att Hold, 4.7.1.4		Limit cycle, maximum deadband, and low rate should be selected for propellant conservation until prior to thrusting.
LMP	5	Configure & preload bats		Prepares for battery preloading prior to CM/SM separation and verifies batteries transferred to main buses.
		<u>CAUTION</u> If either bat bus A(B) current fails to incr after cycling MN BUS TIE sws, configure bats to mn buses using cb BAT C TO BAT BUS A(B).	250	Assumes reconfiguration BAT A(B) and BAT C to MNA(B).

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP				
-10:00		MN BUS TIE BAT A/C - on (up)	5	
		Verify bat bus A current incr &/or bat voltage decr	3	Verification of current increase for appropriate battery bus via DC AMPS indicator (panel 3) confirms successful operation of main bus tie motor switches. MN BUS TIE BAT A/C and B/C switches at on provide two batteries on line if circuit breakers MNA & B BAT C (2) - open, or three batteries on line for deorbit and entry if circuit breakers closed (panel 275).
		MN BUS TIE BAT B/C - on (up)	5	
		Verify bat bus B current incr &/or bat voltage decr	3	
-05:00				
CMP	6	Check boresight star		
	7	For X-axis thrust ΔV Setup, 4.7.6.2		If G&N inoperative, X axis only direction ΔV can be measured.
	8	If P47 for thrust mon Key V37E 47E	2	G&N monitoring desirable but not required. Refer to 4.8.1.6 for P47 description.
		Poss PROG alarm (4.8.1.16)		R02.
		FL V16 N83 ΔVX, Y, Z (cont) XXXX.X FPS		
		If desired Key N62E		
		VI XXXXX. FPS		Inertial velocity.
		H dot XXXXX. FPS		Altitude rate.
		H pad XXXX.X NM		Altitude above pad radius (earth orbit) or landing site radius (lunar orbit).
		KEY REL (to return to N83)		

SCS HYBRID DEORBIT THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
-00:30				
CDR, CMP	9	RHC (both) - ARMED		
CDR		THC - ARMED		
		ATT DBD - MIN	1	
		LIM CYCLE - OFF		
LMP		TAPE RCDR FWD - FWD	3	
CDR		EMS MODE - NORM	1	4.6.1.1, note 9.
00:00				
	10	Perform SM RCS thrust Mon ΔV ind or EVNT TMR ind		
	11	SM RCS thrust complete EMS MODE - STBY Rcd ΔV ind, EVNT TMR ind		4.6.1.1, note 9.
	12	Sel SCS Att Cont mode, 4.7.1		
	13	Perform Sep proced, 4.15.2		Separation at SM deorbit attitude saves time. Only one minute allowed between burns.
	14	Mnvr to CM RCS deorbit att R ___°, P ___°, Y ___° Verify using external visual cues	2	Both CM RCS systems should be enabled. CM RCS portion completed with +X axis ≈70° below velocity vector (apex down and forward); ≈110° +pitch maneuver from heads down, BEF, SM RCS portion of deorbit.
		MAN ATT ROLL, YAW - RATE CMD	1	
		MAN ATT PITCH - ACCEL CMD		
		RATE - HI		
		FDAI SCALE - 5/5		
	15	EVNT TMR ind - SM RCS C/O +1 min EMS MODE - NORM		One minute after SM RCS cutoff, start CM RCS burn. 4.6.1.1, note 9.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		RHC 1 - contin -pitch	2	Negative pitch jets have ≈25 to 30 percent less authority than positive jets because of jet location and thrust direction relative to CM c.g.
CDR		RHC 2 - pulse +pitch to maintain att in 3 axes	1	
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx If only 1 RHC Pulse RHC + & - ≈5° pitch from pitch retro att, maintaining rates <3°/sec xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	16	Mon ΔV ind or EVNT TMR ind for req value		ΔV ind cutoff cue must be adjusted to account for EMS sensing axis (along X) being reversed from SM RCS burn and biased off ≈70° from CM RCS velocity vector. (ΔVems = ΔVcm Cos 70°).
	17	Term CM RCS deorbit burn MAN ATT (3) - RATE CMD or ACCEL CMD EMS MODE - STBY Rcd ΔV ind THC - LOCKED		4.6.1.1, note 9.
	18	Set up for CM RCS Sys 1 AUTO RCS A/C ROLL (4) - OFF AUTO RCS CM 1 (6) - MNA or MNB AUTO RCS CM 2 (6) - OFF	8	Electrically isolates system 2 for entry. If a problem develops in system 1, disable affected channel and use direct RCS control.
CMP	19	PRO (exit P47)	2	
	20	FL V37 Key XXE Go to SCS Entry, 4.15.4		

SCS HYBRID DEORBIT THRUSTING

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.14 ALIGNMENTS		For general G&C operating data, refer to operating notes, 4.6.1.
		4.14.1 G&N ALIGNMENTS		
		4.14.1.1 (P51/P53) IMU Orientation Determination		(P51) IMU Orientation Determination defines inertial orientation of IMU using optics. (P53) Alternate LOS IMU Orientation Determination defines inertial orientation of IMU using backup optical device (COAS). P53 may also be used with failed optics or MARK pb.
		CMC - on (req), 4.8.1.3 ISS - on (req), 4.8.1.3 SCS - on (desired), 4.8.4.2		Provides total attitude monitoring and attitude control capability. Minimum impulse control using RHC available (SCS & G&N) for sighting mark target alignment.
CDR		LOGIC 2/3 PWR - on (up) (req if no SCS) Opt - on (req, P51), 4.8.1.4 COAS - calib (req, P53), 4.14.1.6	7	Required for control and display functions. Optics required for P51; COAS used for P53.
		Att Cont (req), 4.7.1		Allows maneuvering, and provides inertial stability of CSM to ensure accuracy of alignments.
		Total Att Disp (req), 4.7.2.5		Both ISS and GDC attitude displays recommended for monitoring of IMU coarse align and SC motion.
CMP	1	Key V37E 51E/53E	2,140	
		Poss PROG alarm (4.8.1.16)		R02.
	2	FL V50 N25 00015 (trgt acq)		Targets (celestial bodies).

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	a.	Desired att cont mode, 4.7.1		V16 N20 may be keyed in to monitor for impending gimbal lock if operating from LEB where no FDAI available.
		Mnvr to acq tgts, if necessary		
		PRO	2,140	
		If P51 go to 3		
		If P53 go to 4		
	or b.	To coarse align IMU to SC axes		Time and RCS fuel may be saved and subsequent IMU alignment decisions greatly simplified if IMU left inertially stabilized as close as possible to orientation required for future CMC programs.
		ENTR (when att acpt)		
		V41 N22 (coarse align)		
		R, P, Y 000.00 DEG		
		NO ATT lt - on, then out		
		Recycle 2		
		(R53, Sighting Mark Routine)		
	3	FL V51 (please mrk)		
		OPT ZERO - OFF	122	
		OPT MODE - MAN		
		Ctr trgt in SXT		SCT may be used if reduced accuracy acceptable.
		MARK (on trgt), go to 6		
		(R56, Alternate LOS Sighting Mark Routine)		To perform sighting marks using COAS.
	4	FL V06 N94	2,140	
		SA XXX.XX DEG		
		TA XX.XXX DEG		

(P51/P53) IMU ORIENTATION DETERMINATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Accept PRO Reject Key V24E Load desired SA & TA	2,140	Values obtained from COAS Calibration, 4.14.1.6. Nominal SA and TA for COAS sightings are: SA - 000.00 DEG TA - 57.470 DEG
	5	FL V53 (please mrk) RHC - ctr trgt in COAS reticle		SCS minimum impulse mode is recommended.
		ENTR, go to 6		CMC interprets ENTR as a mark. An inadvertent PRO instead of ENTR will recycle FL V53.
	6	FL V50 N25 00016 (term mrks)		
		Accept PRO Reject If P51, MARK REJ pb - push Return to 3	122	An unsatisfactory mark may be rejected by pressing MARK REJ pushbutton (P51) or ENTR (P53) anytime prior to terminating marking sequence. In P51, possible program alarms if marks rejected without prior marks or if surplus marks made.
		If P53, ENTR, return to 5	2,140	CMC interprets ENTR as a mark reject.
	7	FL V01 N71 Trgt code 000XX		Target (celestial body) codes: 00 - Planet (any planet except Earth) 01 to 45 - Star 46 - Sun 47 - Earth 50 - Moon
		Accept PRO		
		Poss OPR ERR Recycles disp		Target code negative or >50.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Reject Key V21E Load trgt code	2,140	
		For trgt 2 (trgt code ≠ 00) P51, return to 3 P53, return to 4		
	8	FL V06 N88 (planet only) X, Y, Z .XXXXX		This flash will occur only if marks were made on a planet. X, Y, Z - components of planet unit position vector at present time.
		Accept PRO Reject Key V25E Load desired data		Use on-board tables to determine planet position vector at present time.
		For trgt 2 P51, return to 3 P53, return to 4		
		(R54, Sighting Data Display Routine)		Tests accuracy of pair of target sightings.
	9	FL V06 N05 Sighting angle diff XXX.XX DEG		
		Accept PRO Reject Key V32E, return to 2		CMC calculates and stores IMU orientation as REFSMMAT.
	10	FL V37 Key XXE		R00.
	11	If P51 and no P52 Opt Pwr Down, 4.8.1.4		

(P51/P53) IMU ORIENTATION DETERMINATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.14.1.2 (P52/P54) IMU Realign		(P52) IMU Realign, and (P54) Alternate LOS IMU Realign, aligns IMU from known orientation to one of four orientations selected by crew. Sightings made on two targets (celestial bodies) with optics in P52, or with COAS in P54. Orientation options available are: • Preferred • Nominal • REFSMMAT • Landing site
		CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (desired), 4.8.4.2		Provides total attitude monitoring and attitude control capability. Minimum impulse control using RHC available (SCS & G&N) for sighting mark target alignment.
CDR		LOGIC 2/3 PWR - on (up) (req if no SCS) Optics - on (req, P52), 4.8.1.4 COAS - calib (req, P54),4.14.1.6	7	Required for control and display functions. Optics required for P52; COAS used for P54.
		Att Cont (req), 4.7.1		Allows maneuvering, and provides inertial stability of CSM to ensure accuracy of alignments.
		Tot Att Disp (req), 4.7.2.5		Both ISS and GDC attitude displays recommended for monitoring of IMU coarse align and SC motion.
CMP	1	Key V37E 52E/54E	2,140	
		Poss PROG alarm (4.8.1.16)		R02.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	2	FL V04 N06	2,140	If preferred orientation defined, R2 = 00001. Otherwise R2 = 00003 (REFSMMAT alignment).
		Option code 00001 Option 0000X		Options available are: 00001 - Preferred (operator ensures preferred orientation defined) 00002 - Nominal 00003 - REFSMMAT 00004 - Landing site
		Accept PRO Reject Key V22E Load desired option		
		a. If 00001 sel, go to 5 or b. If 00002 or 0004 sel, go to 3 or c. If 00003 sel, go to 8		
	3	FL V06 N34 GET align 00XXX. HRS 000XX. MIN 0XX.XX SEC		GET align - Time at which nominal orientation defined. Display initially 0, 0, 0. If this value accepted, nominal orientation will be defined for GET align automatically selected as present time.
		Accept PRO If option 2, go to 5 Reject Key V25E Load desired GET align		
	4	FL V06 N89 Lat (+N) XX.XXX DEG Long/2 (+E) XX.XXX DEG Alt XXX.XX NM		Stored landing site coordinates.
		Accept PRO Reject Key V25E Load correct coordinates		

(P52/P54) IMU REALIGN

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	5	FL V06 N22 R, P, Y XXX.XX DEG Accept PRO Reject Desired att cont mode, 4.7.1 Mnvr SC Key V32E or Key V37E XXE Exit P52/P54	2,140	 To obtain acceptable MGA. V32E recycles to update gimbal angle display.
	6	FL V50 N25 00013 (coarse align or pulse torque) Coarse align PRO, go to 7 Pulse torque ENTR V16 N20 (present gmbl angles) R, P, Y XXX.XX DEG Go to 20		Selects coarse align R50 and allows auto optics positioning. To pulse torque gyros. Bypasses R50 and auto optics positioning. If it appears that IMU will be torqued into gimbal lock, maneuver should be performed to avoid condition. If SC CONT at CMC and CMC MODE at AUTO or HOLD, the DAP will maneuver vehicle to follow platform as it moves. If N93 used for display, scaling of N93 will not remain XX.XXX. Initially, N93 will display proper values; thereafter, R2, then R3, and finally R1 will diminish to zero as each gyro axis is torqued.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R50, Coarse Align Routine)		
CMP	7	Verify coarse align complete NO ATT lt - on, then out Mon ball motion	2,140	If required gimbal angle change <1 degree, IMU will not be coarse-aligned.
	8	FL V50 N25 00015 (trgt acq)		
		a. For CMC assist in sel Desired att cont mode, 4.7.1 Mnvr to acq trgt		After target acquisition, SCS minimum impulse operation desirable for minimum fuel consumption and reduction of vehicle rates to minimum.
		PRO		CMC performs target selection routine. However, for P54, since primary optics are not being used, selected stars may not be acceptable for backup optics sightings.
		Poss FL V05 N09 00405 (accept pair not avail) Mnvr until suitable trgt acq PRO, go to 9		
		or Key V32E, recycle 8		
	or	b. To bypass CMC sel ENTR		Crew manually acquires target.

(P52/P54) IMU REALIGN

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	9	FL V01 N70	2,140	
		Trgt code 000XX		Target (celestial body) codes: 00 - Planet (any planet except Earth) 01 to 45 - Star 46 - Sun 47 - Earth 50 - Moon
		Accept If P52		
		OPT ZERO - OFF	122	
		OPT MODE - as desired		
		PRO	2,140	
		If P54		
		PRO		
		Poss OPR ERR Recycles disp		Target code negative or >50.
		Reject Key V21E Load desired code		
		For P52 If trgt code ≠ 00 & OPT MODE - CMC, go to 11	122	
		or OPT MODE - MAN, go to 12		
		For P54 If trgt code ≠ 00, go to 13		
	10	FL V06 N88 (planet only)	2,140	
		X, Y, Z .XXXXX		X, Y, Z - Components of planet unit position vector at present time.
		Accept If P52 PRO		
		If OPT MODE - MAN, go to 12	122	

STA/T STEP	PROCEDURE	PANEL	REMARKS
	If P54		
CMP	PRO, go to 13	2,140	
	Reject Key V25E Load desired data		Use on-board tables to determine planet position at present time.
	(R52, Auto Optics Positioning Routine)		Points SLOS of optics at selected target.
11	V06 N92 (desired opt angles) SA XXX.XX DEG TA XX.XXX DEG		Optics will drive to acquire selected target. No display if R52 reselected after R53 called.
	Poss FL V05 N09 (2 sec priority) 00404 (TA >90°)		
	a. Desired att cont mode, 4.7.1 Mnvr to reduce TA		If required optics angles not being displayed, key V16 N92E to obtain display.
	PRO		
	or b. Key V34E FL V37 Key XXE		ROO.
	If TA >50° & <90° Desired att cont mode, 4.7.1		If TA >50° and <90°, trunnion driven to upper limit (≈49.7754°) and held at this angle.
	Mnvr to reduce TA		If required optics angles not being displayed, key V16 N92E to obtain display.
	When sighting mrks are desired OPT MODE - MAN	122	Calls R53. To regain auto optics positioning, select OPT MODE - CMC (prior to completion of R53).

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R53, Sighting Mark Routine)		
CMP	12	FL V51 (please mrk) Ctr trgt in SXT MARK (on trgt), go to 15	2,140 122	SCT may be used if reduced accuracy acceptable.
		(R56, Alternate LOS Sighting Mark Routine)		To perform sighting marks using COAS.
	13	FL V06 N94 SA XXX.XX DEG TA XX.XXX DEG	2,140	
		Accept PRO Reject Key V24E Load desired SA & TA		Values obtained from COAS Calibration, 4.14.1.6. Nominal SA and TA for COAS sightings are: SA - 000.00 DEG TA - 57.470 DEG
	14	FL V53 (please mrk) RHC - ctr trgt in COAS reticle		SCS minimum impulse mode recommended.
		ENTR		CMC interprets ENTR as a mark. An inadvertent PRO instead of ENTR will recycle FL V53.
	15	FL V50 N25 00016 (term mrks)		
		Accept PRO Reject If P52, MARK REJ pb - push Return to 12	 122	An unsatisfactory mark may be rejected by pressing MARK REJ pushbutton (P52) or ENTR (P54) anytime prior to terminating marking sequence. In P52, possible program alarms if marks rejected without prior marks or if surplus marks made.

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP		If P54, ENTR Return to 14		2,140	CMC interprets ENTR as a mark reject.
	16	FL V01 N71 Trgt code	000XX		Target (celestial body) codes: 00 - Planet (any planet except Earth) 01 to 45 - Star 46 - Sun 47 - Earth 50 - Moon
		Accept PRO			
		Poss OPR ERR Recycles disp			Target code negative or >50.
		Reject Key V21E Load trgt code			
		If trgt code ≠ 00 Return to 9 for trgt 2			
	17	FL V06 N88 (planet only) X, Y, Z	.XXXXX		This flash will occur only if marks were made on a planet. X, Y, Z - Components of planet unit position vector at present time.
		Accept PRO Reject Key V25E Load desired data			Use on-board tables to determine planet position vector at present time.
		Return to 9 for trgt 2			

(P52/P54) IMU REALIGN

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		(R54, Sighting Data Display Routine)		Tests accuracy of pair of target sightings.
CMP	18	FL V06 N05 Sighting angle diff XXX.XX DEG Accept PRO Reject Key V32E, go to 20	2,140	
		(R55, Gyro Torquing Routine)		Calculates and displays gyro torquing angles for final (fine) alignment of inertial platform and to torque gyros.
	19	FL V06 N93 (Δ gyro angles) X, Y, Z XX.XXX DEG		X, Y, Z Gyro - Angle through which each gyro must be torqued to complete fine alignment. Once this step is complete, CMC will reset preferred orientation flag. If CMC MODE switch is at AUTO or HOLD during R55, the DAP will maneuver CSM to follow platform as it moves.
		Accept PRO (gyros torqued) Reject Key V32E, go to 20 or Key V37E 00E, go to 22		Pulse IRIGs through desired angle. Do not torque gyros.
	20	FL V50 N25 00014 (fine align check) Accept PRO, return to 8 Reject ENTR		PRO repeats target sightings (R52 & R53) for P52; (R56) for P54 sighting data test (R54), and gyro torquing (R55) to verify accuracy of alignment.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	21	FL V37 Key XXE	2,140	R00.
	22	If P52 Opt Pwr Down, 4.8.1.4		

(P52/P54) IMU REALIGN

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.14.1.3 (V40 N20) Zero ICDU Extended Verb		• Ensures synchronization between ISS CDU counters and CDU counters in CMC.
		CMC - on (req), 4.8.1.3 ISS - on (req), 4.8.1.3		• Terminates IMU coarse align mode and enters fine align mode (inertial IMU).
CMP	1	Key V40 N20E NO ATT lt - OFF Wait 15 sec	2,140	
		Poss OPR ERR		If IMU stall routine in use.
		Poss PROG alarm Exit routine Key V05 N09E (to verify alarm) 00206 (zero encode not allowed) Key V41 N20E, 4.14.1.4		If ISS in coarse align mode with gimbal lock.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.14.1.4 (V41 N20) Coarse Align ICDU Extended Verb		Coarse aligns IMU to gimbal angles specified by crew.
		CMC - on (req), 4.8.1.3 ISS - on (req), 4.8.1.3		
CMP	1	Key V41 N20E	2,140	
		Poss OPR ERR Exit coarse align		Occurs if another extended verb active, or if IMU stall routine in use.
	2	FL V21 N22 (load CDU angles) R, P, Y XXX.XX DEG		Registers initially blank.
		Accept Load desired angles Reject V33E		4.6.1.3, note 3m.
		DSKY - V41 NO ATT lt - on		NO ATT lt will remain on even after gimbals have been driven to specified angles.
		Poss PROG alarm Key V05 N09E (to verify alarm) 00211 (error >2°)		Present and specified gimbal angles may be compared by keying V16 N20E and V16 N22E. Alternate method is to key V62E (Mode 2) to display difference between N20 and N22 on FDAI error needles.
		To repeat coarse align Key V41 N20E		
	3	To extinguish NO ATT lt & term coarse align Key V40 N20E Wait 15 sec		Zero ICDU extended verb, 4.14.1.3.
		or V42E		Torque gyros extended verb, 4.8.3.2.

(V41 N20) COARSE ALIGN ICDU EXTENDED VERB

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.14.1.5	<u>(V41 N91) Coarse Align OCDU Extended Verb</u>		Drive optics to shaft and trunnion angles specified by crew. Not permitted from start of drive test until end of burn. (Ref note opposite 00117 alarm, step 3.)
		CMC - on (req), 4.8.1.3 Opt Pwr Up (req), 4.8.1.4		
CMP	1	Key V37E 00E	2,140	V41 N91 from P00 only.
	2	OPT ZERO - OFF OPT MODE - CMC	122	
	3	Key V41 N91E	2,140	
		Poss OPR ERR Exit coarse align OCDUs		Occurs if another extended verb active.
		Poss PROG alarm Key V05 N09E (to verify alarm) 00115 (OPT MODE not CMC)		OPR ERR lt on.
		OPT MODE - CMC	122	
		or 00117 (OPT not avail) Exit coarse align	2,140	This alarm code indicates that OCDUs are being used by TVC DAP or gimbal drive test and that this procedure cannot be performed. May occur from start of drive test until end of burn.
	4	FL V21 N92 (Load OCDUs) SA XXX.XX DEG TA XX.XXX DEG		Registers initially blank.
		Accept Load desired SA & TA Reject V33E		4.6.1.3, note 3m.
	5	DSKY - V41		Key V16 N91E to monitor optics angles.
	6	Opt Pwr Down, 4.8.1.4		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.14.1.6	Inflight COAS Calibration		Provides method for in-flight calibration of COAS (i.e., equivalent shaft and trunnion angles). Spare COAS light bulbs (2) are stowed in volume U3. When installing COAS on window mount, align (rotate COAS barrel to detent) as indicated by arrow on decal.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2 COAS filter installed (req)		Filter used to reduce glare of reticle image when sighting on low intensity targets.
	1	Opt Pwr Up, 4.8.1.4		
	2	Sel Tot Att Disp, 4.7.2.5		
CMP	3	Key V37E 52E	2,140	
		Poss PROG alarm (4.8.1.16)		R02.
	4	FL V04 N06 Option code 00001		If preferred alignment flag is set, R2 will display 00001. Otherwise, R2 will display 00003 (REFSMMAT alignment).
		Option 0000X		Options available are: 00001 - Preferred (operator ensures preferred orientation defined) 00002 - Nominal 00003 - REFSMMAT 00004 - Landing site
		Sel REFSMMAT orient (V22E, 3E) PRO		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	5	FL V50 N25 00015 (trgt acq) Att Cont Mode, 4.7.1 Mnvr to acq trgt in COAS ENTR	2,140	Target (celestial bodies).
	6	FL V01 N70 Trgt code 000XX		Target codes: 00 - Planet (any planet except Earth) 01 to 45 - Star 46 - Sun 47 - Earth 50 - Moon
		OPT ZERO - OFF OPT MODE - CMC	122	
		Reject Key V21E Load trgt code of trgt centered in COAS Accept PRO	2,140	
		Poss OPR ERR Recycles display		Target code negative or >50.
		If trgt not a planet, go to 8		
	7	FL V06 N88 (planet only) X, Y, Z .XXXXX		X, Y, Z - Components of planet unit position vector at present time.
		Accept PRO Reject Key V25E Load desired data		

STA/T	STEP	PROCEDURE		PANEL	REMARKS
		(R52, Auto Optics Positioning Routine)			
CMP	8	V06 N92 SA TA	 XXX.XX DEG XX.XXX DEG	2,140	Display will be updated every ≈0.5 second.
		When trgt centered in COAS & SA & TA relatively constant Key VERB (to freeze disp)			
		Accept Rcd SA & TA for use in P53/P54 Reject KEY REL Repeat 8			
	9	Opt Pwr Down, 4.8.1.4			
	10	Sel new prog			

INFLIGHT COAS CALIBRATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.14.2 SCS ALIGNMENTS		
		4.14.2.1 Alternate SC Inertial Attitude Determination and GDC Alignment		
		SCS - on (req), 4.8.4.2		
	1	Opt Pwr Up, 4.8.1.4		
	2	Sel Tot Att, Att Err & Rate Disp for SCS, 4.7.2		If IMU off, only FDAI 1 need be powered or selected.
	3	Sel SCS Att Hold/Rate Cmd, 4.7.1.4		For fuel conservation, max deadband preferred until stars obtained.
CMP	4	Obtain 2 stars in SCT	121	
		Sel Opt Cont, 4.7.5.2		
		OHC - ctr star on R-line		OHC - Optics hand control.
		OHC - ctr star in FOV		
		Hold star 1 in ctr of FOV		Final adjustment required OPT COUPLING - DIRECT.
		Hold star 2 on R line		Minimum impulse control can be used to allow positioning of stars on R line.
CDR	5	BMAG MODE (3) - RATE 2	1	Stars must be kept aligned while BMAGs caged.
		ATT DBD - MIN		
		BMAG MODE (3) - ATT 1/RATE 2		

4.14.2.1 ALTERNATE SC INERTIAL ATTITUDE DETERMINATION AND GDC ALIGNMENT

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	6	Read & rcd angles on trun & shft ind(s) & xmit with star data to MSFN	121	
	7	Obtain inertial att values for ATT SET tw from MSFN		
	8	Align GDC to MSFN values, 4.7.3		
	9	Opt Pwr Down, 4.8.1.4		

ALTERNATE SC INERTIAL ATTITUDE DETERMINATION AND GDC ALIGNMENT

STA/T	STEP	PROCEDURE		PANEL	REMARKS
	4.14.2.2	Inplane GDC Alignment			Provides method for aligning SCS attitude reference system in orbital plane (+Y axis of reference along V x R). This allows use of ORDEAL on FDAI 2 with IMU out of plane.
		CMC - on (req), 4.8.1.3 ISS - on & orient known (req), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2			
	1	Sel Tot Att Disp, 4.7.2.5			
CDR		FDAI SEL - 1/2		1	
CMP	2	Key V37E 52E		2,140	
		Poss PROG alarm (4.8.1.16)			R02.
	3	FL V04 N06			
		Option code	00001		
		Option	0000X		Options available are: 00001 - Preferred (operator ensures preferred orientation defined) 00002 - Nominal 00003 - REFSMMAT 00004 - Landing site
		Select nom option Key V22E 2E			
		PRO			
	4	FL V06 N34			
		GET align	00XXX. HRS 000XX. MIN 0XX.XX SEC		GET align - Time at which vehicle position and velocity vectors selected to define IMU local vertical orientation.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Key V25E Load present time plus 10 min	2,140	
	5	Establish Att Cont, 4.7.1		Selected to prevent drift between gimbal angle calculation and GDC alignment.
		Damp veh rates		
		PRO		
	6	FL V06 N22 R, P, Y XXX.XX DEG		IMU gimbal angles for desired IMU orientation at present SC attitude.
CDR	7	ATT SET tw - adj to Euler angles disp on DSKY	1	
	8	Align GDC, 4.7.3		
	9	Sel new program		

INPLANE GDC ALIGNMENT

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.14.2.3 Backup GDC Alignment With COAS		Aligns GDC without IMU, CMC or optics.
		SCS - on (req), 4.8.4.2 CMC - off or STBY (req)		A more accurate alignment can be performed if COAS calibration procedure, 4.14.1.6, has been performed earlier and calibration information provided to MSFN for use in computation of R, P and Y ALIGN.
CMP	1	Rcd following data from MSFN GDC Align Values (step 2) R ALIGN ____, P ALIGN ____ Y ALIGN ____		
		Boresight star data (step 13) Boresight star SPA ____° SXP ____°		SPA - Sight pitch angle SXP - Star X position
		Nav stars Prim star ____ (step 5) Sec star ____ (step 8) Star diff angle ____° (step 7)		Star difference angle cannot exceed 35° since this is maximum COAS field of view in pitch.
CDR	2	SCS att set for FDAI 1, 4.7.2.4 ATT SET tw - set R, P, Y ALIGN	1	
	3	Install COAS & set reticle to 0° pitch		
	4	Sel SCS att cont mode, 4.7.1		
	5	Mnvr to position prim star on crosshairs of COAS reticle		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	6	Establish att hold with min P & Y dbd		
	7	Pitch COAS reticle up Star Angle Diff value		
	8	Roll SC to place sec star on pitch axis of COAS reticle		
	9	Establish att hold with min roll dbd		
	10	Repeat 3 through 9 as necessary		
	11	Align GDC, 4.7.3 GDC ALIGN pb - push, when stars positioned, until err null on FDAI 1	1	
	12	Mnvr to ΔV att ATT SET tw - set to ΔV att Mnvr Null errors on FDAI		
	13	Perform Boresight Star ck		

BACKUP GDC ALIGNMENT WITH COAS

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.14.3 BACKUP GDC AND/OR IMU ALIGNMENT		Aligns GDC and/or IMU without CMC.
		SCS - on (req), 4.8.4.2 CMC - off or STBY (for step 3a)		
CMP	1	Rcd following data from MSFN GDC Align Values (step 8) R ALIGN_____, P ALIGN_____, Y ALIGN_____		
		SXTS data (step 10) SXTS_____ SHAFT_____° TRUN_____°		SXTS - Sextant star.
		Boresight star data (step 4) Boresight star_____ SPA_____° SXP_____°		SPA - Sight pitch angle. SXP - Star X position. 0° and 0° allows SC to be rolled about boresight star in 7.
		Nav stars (step 7) Prim star_____(0° mark on R line of SCT reticle) Sec star_____(R line)		
	2	ISS att set for FDAI 1, 4.7.2.4		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	3	Cage IMU		This step is bypassed, if only GDC aligned.
		If IMU in stby IMU PWR - on (up) (IMU automatically cages)	100	Guarded. Occurs only if CMC off, or in STBY.
		If IMU powered up		
		a. IMU PWR - OFF Wait 5 min for gyros to run down IMU PWR - on (up)		Guarded. Guarded.
CDR		or b. ATT SET tw - set to 0°, 0°, 0° Mnvr SC to 0°, 0°, 0° & null FDAI 1 errors	1	IMU gimbal angles should be 0±5° before caging to avoid damaging gyros.
		IMU CAGE - on (up) & hold until 11		Guarded.
	4	Sel desired SCS Att Cont Mode, 4.7.1, & mnvr to position boresight star in COAS		
	5	Opt Pwr Up, 4.8.1.4		
CMP	6	Set opt to 0° shft & 352.5° trun, 4.7.5		0° shaft and 352.5° trunnion places 0° mark of SCT reticle along +Zsc axis.
		OPT PWR - OFF	100	Eliminates optics drift.
	7	Mnvr to position stars in SCT		Roll SC around boresight star to acquire navigation stars. After positioning primary star on 0° mark, SC may be yawed about this star to place secondary star on R line.

BACKUP GDC AND/OR IMU ALIGNMENT

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	8	Align GDC ATT SET tw - set to R, P, Y ALIGN ATT SET - GDC GDC ALIGN pb - push when stars positioned, until err null on FDAI 1	1	ELEC PWR - GDC/ECA (required for GDC ALIGN) satisfied by SCS Power Up, 4.8.4.2.
	9	Mnvr to ΔV att ATT SET tw - set to ΔV att Mnvr Null err on FDAI 1		
	10	Perform SXTS ck & adj SC att if necessary		With optics set to proper shaft and trunnion angles, and SC at ΔV attitude, specified star should appear in SXT.
	11	Uncage IMU IMU CAGE - on (up) and rel If 3b was used IMU CAGE - rel		This frees IMU at 0°, 0°, 0°. (For deorbit, GDC will be at 180°, 180°, 0°.)
	12	Opt Pwr Down, 4.8.1.4		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.15 ENTRY		
		4.15.1 DEORBIT OR LUNAR RETURN VEHICLE PREPARATION		
		(Proced in 4.15.1.1 thru 4.15.1.4 not designated as "req" are optional)		Deorbit preparation applies to any deorbit (SPS or RCS, pure or hybrid, whether G&N, SCS or manually controlled) and should be done prior to deorbit thrust to minimize crew workload between deorbit and entry. For lunar return, preparation accomplished after final MCC and during coast period prior to SM separation from CM.
		4.15.1.1 <u>General System Management</u>		
		Cab Cold Soak Oper (GETI or EI minus 8 to 12 hrs), 4.5.4.13		Provides cabin heat-sink during entry. EI (entry interface) ≈400,000 feet.
	or	If no cold-soak		
CMP		SEC EVAP H2O CONT - AUTO (req)	382	
		If lunar return CMC - on, 4.8.1.3 ISS - on & orient known, 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2 DAP Data Load - complete, 4.8.2.1		
	1	Obtain update & entry data from MSFN		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP	2	If deorbit Configure TLM (req) TAPE RCDR FWD - off (ctr) PCM BIT RATE - HI UP TLM CMD - RSET, then NORM Propul Sys Checks, 4.5.2.1 thru 4.5.2.3	3	After MSFN dumps and rewinds tape recorder and returns DSE control to crew at last contact prior to deorbit, TAPE RCDR FWD switch placed to off (center) and PCM BIT RATE switch to HI.
	3	If lunar return Configure telcom (req) VHF AM A - SIMPLEX Propul Sys Checks, 4.5.2.2 & 4.5.2.3		
	4	EPS DC & AC checks, 4.5.3.3 & 4.5.3.4 PYRO BAT A & B >35 vdc (verify) xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x x If PYRO BAT A(B) <35 vdc cb PYRO A(B)/SEQ A(B) - open cb BAT BUS A(B) TO PYRO BUS - close x x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	 250	
	5	ECS Mon Check, 4.5.4.1		
CMP	6	Stow gas separator cartridges (req) Remove separator bags from stowage Disconnect separators from water pistol & food prep unit Place separators in stowage bags Stow separators	352	

DEORBIT OR LUNAR RETURN VEHICLE PREPARATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	7	Stow loose gear (req)		
	8	Dry tunl		If necessary, absorb water with towel. Condensed moisture rains on crew.
	9	CMC Self-Check Proced, 4.8.1.7		
	10	DSKY Condition Lt Check, 4.8.3.1		
	11	C&WS Oper Check, 4.5.5.1		
	12	P52 IMU Align, 4.14.1.2		
	4.15.1.2	<u>RSI Test and Alignment</u>		Permits testing EMS roll stability indicator (RSI) and positioning to desired orientation for entry.
CDR		ELEC PWR - GDC/ECA	7	
		ATT SET - GDC	1	
	1	EMS ROLL - on (up)		
		GDC ALIGN pb - push, hold		
		ATT SET YAW tw - adj thru 45° angle, observe RSI tracks ≈45°, then position RSI		Avoid FDAI gimbal lock region.
		GDC ALIGN pb - rel		
		EMS ROLL - OFF		
	2	ATT SET YAW tw - reset		This step required only if GDC was aligned and realignment required.
		GDC ALIGN pb - push (32 sec max)		
	4.15.1.3	<u>EMS Entry Test</u>		Light illumination other than those listed indicates a malfunction. Lift vector up (G >0.2) and down (G <0.2) lights for entry from lunar mission only. ΔV/EMS SET switch slews G-V scroll and sets RNG indicator.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	1	Init EMS prep		
CDR		EMS FUNC - OFF (verify)	1	
		cb EMS (2) - close	8	
		EMS MODE - STBY	1	
	2	EMS FUNC - EMS TEST 1 (CCW)		Test 1 checks .05 G comparator lower trip-point.
		Wait 5 sec		
		Adj alphanumeric brightness (option)		
		EMS MODE - NORM		
		Wait 10 sec min		Ten seconds should be allowed to verify no malfunctions. No light on before or after 10 seconds.
		All ind lts - out		
		RNG ind - 0.0		
		Slew scroll until hairline superimposed on notch in next self-test pattern		EMS scroll can be slewed only one inch in reverse.
	3	EMS FUNC - EMS TEST 2		Test 2 checks .05 G comparator upper trip-point. No other light on before or after 10 seconds.
		Wait 10 sec		
		.05 G lt - on (all others out)		
	4	EMS FUNC - EMS TEST 3		Test 3 checks corridor verification circuitry associated with lift vector down light.
		.05 G lt - on		
		Lift vector dn lt - on (10 sec after .05 G lt)		G <0.2.
		Set RNG ind to 58.0$\pm$0.0 NM		RNG indicator displays minus sign for negative numbers or no sign for positive numbers in most significant digit.
	5	EMS FUNC - EMS TEST 4		Test 4 checks range-to-go integrator circuits, range-to-go indicator, G-V servo circuits, and G-V plotter.
		.05 G lt - on (all others out)		
		G-V trace (during 10 sec period) within test pattern		

DEORBIT OR LUNAR RETURN VEHICLE PREPARATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		After 10 sec, G-V trace stops at lower right corner of test pattern at ≈9 G RNG ind (during 10 sec period) counts toward zero. After 10 sec, stops at ≈0.0±0.2 G	1	
	6	EMS FUNC - EMS TEST 5 .05 G lt - on Lift vector up lt - on (10 sec after .05 G lt) RNG ind - 0.0 Scribe traces vert line ≈9 G to 0.28±0.1 G & stops (trace within test pattern) Align G-V scroll to entry pattern (hairline on 37K fps line)		Test 5 checks corridor verification circuitry associated with lift vector up light and enables scroll slewing to start of entry pattern. After scroll set to less than 37K fps, reselecting EMS TEST 5 switch position not permitted; range integrator and scroll synchronization would be lost.
	7	EMS FUNC - RNG SET G-V traces vert line ≈0.28 G to 0.0±0.1 G & stops If lunar return Slew RNG ind to pred RTOGO from .05 G		
	8	EMS FUNC - Vo SET CAUTION Never slew scroll in incr direction more than 1500 fps. Ensures range integrator remains slaved to scroll velocity.		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		Slew scroll until display index (arrow) aligned to pred entry velocity	1	Scroll can be slewed only one inch in reverse. In Vo SET position, both initial velocity in range integrator and scroll velocity change simultaneously.
	9	ΔV Test & Null Bias Check, 4.7.6.1		
	4.15.1.4	<u>Systems Preparation</u>		
		If suited		
		Press Suit Circuit & PGA Check at 5.0 psia, 4.5.4.9		
ALL		Mae Wests - donned		
CMP		EMER CAB PRESS sel - OFF	351	
EI or GETI -1:00:00				
	1	CM RCS temp check		
		SYS TEST (2) - 5C, 5D, 6A, 6B, 6C, 6D	101	Checks CM RCS 12, 14, 16, 21, 24, and 25 jet injector temperatures, respectively.
		If lowest reading <3.9 vdc (28°F)		
CDR		cb CM RCS HTRS (both) - close	8	
		cb RCS LOGIC (2) - close		
		CM RCS LOGIC - on (up)	1	
CMP		CM RCS HTRS - on (up) for 20 min	101	Jet injector valve direct coils utilized for preheating all jets.
	2	URINE DUMP - OFF		
	3	WASTE H2O DUMP - OFF		
	4	Align RSI & GDC, 4.15.1.2		
	5	If deorbit		
		Set FDAI 2 on ORB RATE & restow, 4.8.4.8		

DEORBIT OR LUNAR RETURN VEHICLE PREPARATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP -40:00	6	CM RCS heating completion (if accomplished)		
		CM RCS HTRS - OFF	101	
	7	Configure entry bats (req)		
LMP		cb MNA BAT C - close	275	
		cb MNB BAT C - close		
	8	If SPS deorbit		
		Cryo 02 & H2 Man Fan Opera, 4.5.3.10		
CDR	9	Panel 8 - all cb closed except (req)	8	
		cb PL VENT FLT/PL - open		
		cb FLOAT BAG (all) - open		
		cb EDS (all) - open		
		cb CM RCS HTR (both) - open		
		If lunar return		
		cb SPS PITCH (both) - open		
		cb SPS YAW (both) - open		
	10	Sequencer & CM RCS activation (req)		
		After MSFN AOS		
		SECS LOGIC (both) - on (up)		Lever lock.
		Report logic arm		
		ELS AUTO - AUTO	1	
		ELS LOGIC - on (up)		Guarded.
		After GO from MSFN		
		ELS AUTO - MAN		
		ELS LOGIC - OFF		Guarded.
		SECS PYRO ARM (2) - on (up)	8	Lever lock.
CMP		CM RCS PRPLNT (both) - on (up) (verify)	2	On position is momentary.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		CM RCS PRPLNT tb (both) - gray	2	Gray indicates fuel and oxidizer isolation valves open.
		CM RCS PRESS - on (up)		Guarded. On position is momentary.
		RCS IND sel - CM 1, then 2		
		CM RCS He PRESS ind - 3300-3500 psia (after ≈15 min)		Immediately after pressurization, He pressure less than 3300-3500 psia.
		CM RCS MANF PRESS ind - 287-302 psia		
	11	If deorbit		
		SM RCS SEC FUEL PRESS (4) - OPEN		OPEN position is momentary. No talkbacks. Activates secondary fuel tanks for possible SM RCS deorbit.
		RCS IND sel - SM A		
	12	If docking ring still in place (req)		
		CSM/LM FNL SEP (both) - on (up)		Guarded. On position is momentary. Jettisons docking ring.
CDR	13	SECS PYRO ARM (2) - SAFE	8	Lever lock.
	14	If lunar return, test CM RCS jets		
		SC CONT - SCS	1	
CMP		RCS TRNFR - CM	2	CM position is momentary.
CDR		AUTO RCS CM 1 (6) - MNA	8	
		AUTO RCS CM 2 (6) - MNB		
		cb B/D ROLL, SCS PITCH & SCS YAW MNA (3) - open		
		Test ring 2 jets		
		cb B/D ROLL, SCS PITCH & SCS YAW MNA (3) - close		
		cb B/D ROLL, SCS PITCH & SCS YAW MNB (3) - open		

DEORBIT OR LUNAR RETURN VEHICLE PREPARATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		Test ring 1 jets		
		cb B/D ROLL, SCS PITCH & SCS YAW MNB (3) - close	8	
CMP		RCS TRNFR - SM	2	SM position is momentary.
CDR		SC CONT - CMC	1	
EI -30:00				
LMP	15	If lunar return TAPE RCDR FWD - REWIND	3	
CMP	16	If hatch counterbalance deactivated for EVA (req) Activate counterbalance mechanism, 4.5.7.3, step b	Side hatch	
	17	Strut unlock lanyard (2) - unstow & attach handle ends to MDC (req)		
	18	If SCS, sel P00		
	19	If deorbit Go to THRUSTING, 4.13		
	20	If lunar return Go to CM/SM Sep, 4.15.2		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.15.2 CM/SM SEPARATION		
LMP	1	If SM RCS deorbit or lunar return		Prepares for battery preloading prior to CM/SM separation and verifies batteries transferred to main buses. (Previously configured in SPS or Hybrid Deorbit Thrusting of 4.13.2.1, 4.13.2.3, 4.13.3.1 or 4.13.3.3.)
		CAUTION If either bat bus A(B) current fails to incr after cycling MN BUS TIE switch, configure bats to mn buses using cb BAT C TO BAT BUS A(B).	250	
-12:00		MN BUS TIE BAT A/C - on (up) Verify bat bus A current incr &/or bat volt decr MN BUS TIE BAT B/C - on (up) Verify bat bus B current incr &/or bat volt decr	5	Verification of current increase for appropriate battery bus via DC AMPS indicator (panel 3) confirms successful operation of main bus tie motor switches. MN BUS TIE BAT A/C and B/C switches at on provide 2 batteries on line if cb MNA & B BAT C (2) - open, or 3 batteries on line for entry if circuit breakers closed (panel 275).
CDR	2	Configure RCS AUTO RCS B/D ROLL B1 & B2 - MNA AUTO RCS B/D ROLL D1 & D2 - MNB AUTO RCS PITCH A3 & C4 - MNB AUTO RCS PITCH C3 & A4 - MNA AUTO RCS YAW B3 & D4 - MNA AUTO RCS YAW D3 & B4 - MNB	8	Assumes desired Attitude Control mode, 4.7.1, previously selected.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		SM RCS PRPLNT (4) - OPEN (verify)	2	OPEN position is momentary. Opens 16 quad isolation valves.
		SM RCS PRPLNT tb (8) - gray (verify)		Gray indicates quad fuel and oxidizer isolation valves open.
		SM RCS SEC FUEL PRESS (4) - OPEN (verify)		OPEN position is momentary. No talkbacks. Opens helium isolation valves between quad helium regulators and secondary fuel tanks.
	3	Mnvr to sep att		Nominally deorbit burn attitude plus a 45° yaw out of plane.
CDR		If CMC cont SC CONT - SCS	1	During separation, CSM RCS DAP acting upon CM would produce undesirable rates.
		or CMC MODE - FREE		
CMP	4	If earth orb RCS TRNFR - CM Test jets	2	If lunar mission, jets test fired in Deorbit or Lunar Return Vehicle Preparation, 4.15.1.
		RCS TRNFR - SM		
CDR	5	ATT DBD - MAX RATE - HI	1	Conserves propellant between separation and .05 G.
LMP	6	Configure telcom VHF AM (2) - off (ctr) S BD ANT OMNI A - C S BD ANT OMNI - OMNI If RCS deorbit TAPE RCDR FWD - FWD	3	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP	7	Preload bats		
-08:00		FC2 MNA - OFF	3	
		FC2 MNA tb - bp		Barber pole indicates fuel cell not connected to bus.
-05:00		FC PUMPS (all) - OFF	5	
CMP		HI GAIN ANT PWR - OFF	2	
	8	Configure ECS		
CDR		PRIM GLY TO RAD - BYP (pull)	325	
		REPRESS PKG vlv - FILL	326	Assures CM 02 supply full before CM/SM separation.
		SURGE TK - ON (verify)		
CMP		02 PRESS IND sw - SURGE TK	2	
		CRYO 02 PRESS 1 ind - 865-935 psia		
CDR		REPRESS PKG vlv - ON	326	
		SM 02 SUP vlv - OFF		
LMP		cb ECS RAD CONT/HTRS (2) - open	5	
		cb WASTE H20/URINE DUMP HTRS (2) - open		
		cb RAD HTRS OVLD (2) - open		
CMP		POT H20 HTR - OFF	2	
CDR	9	Arm SECS		
		SECS LOGIC (both) - on (up) (verify)	8	SECS LOGIC and PYRO ARM lever lock switches required for sequencing of separation and landing events.
		SECS PYRO ARM (2) - on (up)		
CMP	10	PRPLNT DUMP - RCS CMD (verify)	2	Was set to RCS CMD 42 seconds after lift-off. CM RCS activated in 4.15.1.4.
CDR		EMS MODE - STBY (verify)	1	Should remain at STBY until just prior to entry interface to preclude false .05 G sensing.
CMP	11	Sep from SM		
00:00		CM/SM SEP (both) - on (up)	2	Guarded. On position is momentary.
		SM C/W lts - on		Low limit SM system lights on at separation.
		C/W CSM - CM		

CM/SM SEPARATION

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STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		MASTER ALARM pb/lt - on, push	1	
CMP		SM C/W lts - out	2	
		RCS TRNFR - CM		CM position is momentary. Backup to automatic RCS transfer.
CDR		CM RCS LOGIC - OFF	1	
	12	Sel Att Cont mode, 4.7.1 Mnvr to entry att (or to SM RCS deorbit att if hybrid deorbit) R ____, P ____, Y ____		Entry DAP not turned on.
	13	Set up for CM/RCS sys 1 (omit for hybrid deorbit)		G&N entry DAP will function with either one or both CM/RCS systems enabled.
		AUTO RCS A/C ROLL (4) - OFF AUTO RCS CM 1 (6) - MNA or MNB AUTO RCS CM 2 (6) - OFF	8	Electrically isolates CM RCS system 2 for entry. If a problem develops in system 1, disable affected channel and use direct RCS control.
	14	Go to P61 Entry Prep, 4.15.3.1		
	or	Go to SCS Entry, 4.15.4		
	or	If G&N Hybrid Deorbit, go to 4.13.2.3 (step 16)		
	or	If SCS Hybrid Deorbit, go to 4.13.3.3 (step 14)		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.15.3 G&N ENTRY		
		4.15.3.1 P61 Entry Preparation		Displays predicted entry interface parameters and obtains EMS initialization parameters for comparison with MSFN values.
		Required CMC - on, 4.8.1.3 ISS - on & orient known, 4.8.1.3 & 4.14 SCS - on, 4.8.4.2		
CMP	1	DSKY - P61 (sel at end of deorbit burn)	2	
	or	Key V37E 61E		
		Poss PROG alarm (4.8.1.16)		R02.
		(R41 - State Vector Integration)		
		COMP ACTY lt - on (R41) COMP ACTY lt - flashes every 2 sec (ave G on)		Indicates state vector integration in process. Indicates integration complete, and average G on.
		Poss PROG alarm V05 N09 (10 sec) 01427 (IMU reversed)		Zero roll on FDAI is lift-down. -Ysm within 30° of V x R. Alarm 01427 always displayed following P40 or P41 deorbit if platform aligned to preferred orientation computed in P40 or P41.
		or 01426 (IMU unsatisfactory for entry)		Neither +Ysm or -Ysm within 30° of V x R.

P61 ENTRY PREPARATION

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	2	FL V06 N61		2	
		Impact Lat (+N)	XXX.XX DEG		Latitude and longitude of desired impact point.
		Impact Long (+E)	XXX.XX DEG		
		Hds Up/Dn (+up)	+/-00001		Heads up/down defines entry roll attitude.
		Accept PRO			
		Reject V25E, load desired values			Normally, these values loaded prior to deorbit.
	3	FL V06 N60 (entry data)			
		G max	XXX.XX G		Predicted maximum G level for an entry at nominal bank angle (L/D = 0.18)
		V pred	XXXXX. FPS		Predicted inertial velocity at entry interface (65.8 NM, 400,000 feet) above Fischer ellipsoid.
		Gamma EI	XXX.XX DEG		Flight path angle (between inertial velocity vector and local horizontal) at 65.8 NM (400,000 feet) above Fischer ellipsoid. Minus indicates flight path below horizontal plane.
		Rcd values			
		PRO			
	4	FL V16 N63			Display relative to erasable preloaded altitude value above Fischer ellipsoid.
		RTOGO (.05 G to splash)	XXXX.X NM		Range to go from preloaded erasable altitude value to splash.
		VIO (at .05 G)	XXXXX. FPS		Predicted inertial velocity at preloaded altitude value.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	TFE (time from .05 G) XXBXX MIN-SEC	2	Predicted time from now to preloaded altitude value (updated every 2 seconds). Predicts about 3 minutes longer than actual, following hybrid deorbit when called half hour before .05 G. Error varies, depending on how early P61 called after deorbit. 59B59 maximum reading (-above, +below).
	Rcd & compare with MSFN		
CDR	EMS MODE - STBY	1	
	EMS FUNC - RNG SET (CW)		Do not go through EMS TEST positions.
	Set RNG ind - RTOGO from .05 G (MSFN value)		Range to go from preloaded value to splashdown.
	Align scroll Vo to exact entry velocity (if req)		Predicted entry velocity may have been preset in EMS Entry Test, 4.15.1.3. Scroll can be slewed only one inch in reverse. In Vo SET position, both initial velocity in range integrator and scroll velocity change simultaneously.
	EMS FUNC - ENTRY		
CMP	Accept PRO (exit P61) P61 calls P62 Go to G&N Entry, 4.15.3.2	2	
	Reject V32E, recycle to 3		Obtains new state vector and updated N60.

P61 ENTRY PREPARATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.15.3.2 P62, P63, P64, P65, P66, P67 Entry		
		Required CMC - on, 4.8.1.3 ISS - on & orient known, 4.8.1.3 & 4.14 SCS - on, 4.8.4.2		
CMP	1	DSKY - P62 Auto sel by P61 (bypasses state vctr extrapolation reqt)	2	
	or	If FL V37 Key 62E		
	or	Key V37E 62E (ave G reinitiated)		
		Poss PROG alarm (4.8.1.16)		R02.
		(R41 - State Vector Integration)		R41 bypassed if P62 called by P61.
		COMP ACTY lt - on (R41) COMP ACTY lt - flash every 2 sec (ave G on)		Indicates integration in process. Indicates integration complete, and average G on.
		Poss PROG alarm V05 N09 (10 sec) 01427 (IMU reversed)		Zero roll on FDAI is lift-down. -Ysm within 30° of V x R. Alarm 01427 always displayed following P40 or P41 deorbit if platform aligned to preferred orientation computed in P40 or P41.
		or 01426 (IMU unsatisfactory for entry)		Neither +Ysm or -Ysm within 30° of V x R.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	2	FL V50 N25 00041 (request CM/SM sep)	2	If CM and SM not separated prior to this step, separation should be accomplished now per 4.15.2. V37s inhibited after response to this display, except P00; programs not requiring DAP control may then be selected from P00. P62 should be reselected before entry into atmosphere because average G terminates by going to P00.
	3	PRO		Starts entry DAP. Roll attitude error scaling changed in G&N for compatibility with 50/15/50/10 FDAI scale position. After PRO and until 50/15/50/10 selected, full scale roll error 20°, not 5°.
	4	FL V06 N61 Impact lat (+N) XXX.XX DEG Impact long (+E) XXX.XX DEG Hds up/down (+Hds up) +/-00001		Latitude and longitude of desired impact point. Defines entry roll attitude.
		Accept PRO If α <45° - DSKY P63, go to 6 Reject V25E, load new data		If α within 45° of (-) velocity vector, P63 automatically called.
	5	V06 N22 (mon) R, P, Y XXX.XX DEG If α >45° 21 sec after α <45°, DSKY P63		Final gimbal angles at EI. Display bypassed and P63 called if α within 45°.
	6	ORDEAL Pitch - ___° (Hds up) ORDEAL Pitch - ___° (Hds down)		IMU inertial attitude on FDAI 1 and ORDEAL local vertical attitude on FDAI 2.
	7	DSKY - P63		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	8	After CM/SM sep & CM stab at entry att		
		EMS MODE - NORM	1	Left in STBY until after separation and stabilization; if no postburn update, and for RCS deorbit, start EMS by positioning EMS MODE from STBY to BU at MSFN supplied value of RET .05 G. Also refer to 4.6.1.1, note 9.
		ATT DBD - MAX		
		RATE - HI		
		FDAI SCALE - as desired		
CDR,CMP		Mon FDAIs & RSI	1,2	
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR		If abnormal veh dynamics		This procedure sequence minimizes failure isolation time. (Another functionally acceptable method disables AUTO RCS switches first, then RHC direct power.)
		Damp rates with dir RCS		
		RHC PWR DIR (both) - OFF	1	
		If abnormal veh dynamics continue		
		RHC PWR DIR (both) - MNA/MNB		
		Damp rates with dir RCS		
		AUTO RCS (affected axis) - OFF	8	
		Continue with dir RCS (affected axis)		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CMP	9	V06 N64 (mon)	2	N68 and N74 available if desired.
		Drag accel XXX.XX G		
		VI XXXXX. FPS		Inertial velocity (nominal).
		Range to splash (+ overshoot) XXXX.X NM		Range to go to desired splashpoint located at calculated impact time (decreasing). Display bypassed on first 2-second cycle.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP		PCM BIT RATE - HI TAPE RCDR RCD - RCD TAPE RCDR FWD - FWD	3	
CDR		BMAG MODE (3) - RATE 2	1	Cages attitude BMAGs. Prevents SCS-driven FDAI roll stability indicator from jumping when GA1 BMAGs automatically cage at .05 G.
		MAN ATT (3) - RATE CMD SC CONT - CMC		Configuration required for auto G&N entry and normally selected at last status check prior to .05 G.
		CMC MODE - AUTO, HOLD, or FREE		Entry DAP does not look at CMC MODE switch.
CMP		DSKY - P64 (at .05 G)	2	CMC changes Entry DAP from attitude hold in alpha and beta to rate damping in pitch and yaw (roll unchanged).
CDR		.05 G sw - on (up) EMS ROLL - on (up)	1	.05 G and EMS ROLL switches should be placed on simultaneously to minimize EMS error.
		.05 G lt - on		.05 G lt will not necessarily occur simultaneously with P64 on DSKY.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx If no .05 G indication by RET .05 G +3 sec EMS MODE - BU xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		At .05 G +10 seconds, one lift vector light will come on; disregard light.
		Scroll slews to left RNG ind decr		

P62, P63, P64, P65, P66, P67 ENTRY

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP	10	V06 N74 (mon)		2	N64 and N68 available if desired.
		Beta	XXX.XX DEG		Commanded bank angle.
		VI	XXXXX. FPS		Inertial velocity (decreasing).
		Drag accel	XXX.XX G		Drag acceleration (increasing).
		Compare RSI & ball for lift vctr G-V plot within limits		1	Violation of an EMS G onset ray should be followed by an orientation to lift vector up. Violation of an EMS G offset ray should be followed by an orientation to lift vector down. If at point of tangency, G&N not commanding lift-up or lift-down, manually orient CM and terminate G&N steering.
	11	If DSKY - P67 Go to 18		2	P64 calls P67 at 0.2 G if VI at .05 G (step 10) <27K fps. Entry velocities $\geq$27K fps are possible from RCS deorbits.
	12	DSKY - P65 (entry up-cont) Indicates VI $\geq$27K fps & constant drag cont has brought range prediction to within 25 NM of desired range			P65 not applicable to low earth orbital mission. Executes entry up-control guidance, which steers CM to calculated reference trajectory, and establishes entry up-control displays for crew use with EMS to determine whether backup procedures should be implemented. Also selects entry-ballistic phase program (P66) if D <DL ($\approx$0.196 G) sensed, or selects final phase program (P67) if D >DL ($\approx$0.196 G) sensed, R dot negative, and V sufficiently low.
CDR		EMS disp - approach DSKY disp DL & VL		1	
CMP	13	FL V16 N69 (computed exit conditions)		2	
		Beta	XXX.XX DEG		Commanded bank angle.
		DL	XXX.XX G		Drag acceleration at end of up control.
		VL	XXXXX. FPS		Velocity at end of up control.

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CMP		Rcd data for later use with EMS			
		PRO		2	N69 may be terminated by PRO, or selection of either P66 or P67 by entry guidance provides automatic termination.
		FDAI att err _______ deg rates _______ deg/sec			
	14	V06 N74 Beta VI Drag accel	 XXX.XX DEG XXXXX. FPS XXX.XX G		N64 and N68 available if desired.
	15	If DSKY - P67 Go to 18			P67 occurs if drag >DL, R dot negative, and V sufficiently low.
	16	DSKY - P66 (entry-ballistic)			Automatically selected by P65 when D <DL (≈0.196 G). Not applicable to low earth orbit mission. N64, N68, N74 available if desired. Maintains CM attitude during ballistic (skipout) phase for atmospheric re-entry and selects P67 when re-entry (drag acceleration builds up to Q7F +0.5 fps squared, ≈0.2 G) sensed.
	17	V06 N22 (desired gmbl angles) R, P, Y	 XXX.XX DEG		
		Check FDAI tot att = DSKY values FDAI att err <_____ deg rates <_____ deg/sec			
		(Three-axis DAP cont regained when <.05 G sensed, & relinquished when .05 G again sensed)			

P62, P63, P64, P65, P66, P67 ENTRY

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP 0.2 G				
	18	DSKY - P67	2	P67 continues entry guidance from ≈0.2 G until termination of steering when CM velocity with respect to earth = 1000 ft/sec (≈10.7 NM altitude). N64, N68, and N74 available if desired.
CDR		EMS - 0.2 G (if 10 sec since .05 G)	1	
CMP	19	V06 N66 (mon)	2	
		Beta XXX.XX DEG		Commanded bank angle (-command will correct for + cross range error).
		CRSRNG ERR XXXX.X NM		CMC solution for cross range error (+ target south of direction of motion).
		DWNRNG ERR XXXX.X NM		CMC solution for down range error (decreasing); + is overshoot. 9999.9 after overshoot of target.
		Key VERB (freeze disp) Compare DWNRNG ERR to pad data (DWNRNG ERR within 100 NM of pad data)		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		If DWNRNG ERR not within 100 NM		
CDR		Maintain BBA entry		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CMP		KEY REL (reinstates V06 N66 mon)		
CDR		Fly roll cmd	1	
		Mon lift vctr on RSI & ball		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	20	FL V16 N67 (mon)	2	
		Range to splash (+ overshoot) XXXX.X NM		Range to go to desired splashpoint (+ is overshoot).
		Lat present position (+N) XXX.XX DEG		Latitude and longitude of present position.
		Long present position (+E) XXX.XX DEG		
		(V REL = 1000 fps at ≈65K')		
		If R1 = -, lift-up; +, lift-down		
CDR		Mon altimeter	1	
		Rcd lat, long, & voice to RECY at 10K'		
		Rcd EMS RTOGO		
		EMS MODE - STBY		
		EMS FUNC - OFF		
	21	Go to Earth Ldg Phase (<50K'), 4.16		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.15.4 SCS ENTRY		Assumes CM and SM separated. During entry, do not "fly to" a pegged rate needle. For this contingency, control to operational attitude ball or out-the-window visual cues.
		CMC - on (desired), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14 SCS - on (req), 4.8.4.2 RSI aligned, 4.15.1.2		
CDR	1	Verify/mnvr to entry att		SCS acceleration command recommended until .05 G for failure takeover considerations.
		EMS Entry Test, 4.15.1.3		May have been done during Deorbit or Lunar Return Vehicle Preparation, 4.15.1.
	2	EMS MODE - STBY EMS FUNC - RNG SET (CW)	1	Do not go through EMS TEST positions. The following steps to be done as soon as possible after deorbit ΔV.
		Set RNG ind - RTGO from .05 G (MSFN value)		
	3	EMS FUNC - Vo SET Realign scroll Vo to exact entry velocity (if req)		Predicted entry velocity preset in step 1 (EMS Entry Test). Scroll can be slewed only one inch in reverse. In Vo SET position, both initial velocity in range integrator and scroll velocity change simultaneously.
	4	EMS FUNC - ENTRY		
	5	Align RSI to desired angle (if necessary) ATT SET - GDC EMS ROLL - on (up)		This alignment may be performed prior to launch or prior to deorbit.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		GDC ALIGN pb - push, hold ATT SET YAW tw - position RSI	1	EMS roll stability indicator alignment provides indication of backup bank angle (BBA).
		GDC ALIGN pb - rel EMS ROLL - OFF ATT SET YAW tw - rset GDC ALIGN pb - push (32 sec max)		
	6	After CM SM sep & CM stab at entry att EMS MODE - NORM		Left in STBY until after separation and stabilization; if no postburn update, and for RCS deorbit, start EMS by positioning MODE switch from STBY to BU at MSFN supplied value of RET .05 G. Also refer to 4.6.1.1, note 9.
		ATT DBD - MAX RATE - HI FDAI SCALE - 50/15/50/10 BMAG MODE (3) - RATE 2 MAN ATT ROLL - ACCEL CMD MAN ATT PITCH & YAW - RATE CMD		Cages attitude BMAGs, preventing SCS-driven FDAI RSI jumping at .05 G when GA 1 attitude BMAGs automatically caged to furnish rate information for SCS-driven FDAI RSI. This configuration can be delayed, as close to .05 G as convenient, for propellant conservation.
LMP		PCM BIT RATE - HI TAPE RCDR RCD - RCD TAPE RCDR FWD - FWD	3	
CDR,CMP		Mon FDAIs & RSI	1,2	

SCS ENTRY

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR		If abnormal veh dynamics Damp rates with dir RCS RHC PWR DIR (both) - OFF	1	This procedure sequence minimizes failure isolation time. (Another functionally acceptable method disables AUTO RCS switches first, then RHC direct power.)
		If abnormal veh dynamics continue RHC PWR DIR (both) - MNA/MNB Damp rates with dir RCS AUTO RCS (affected axis) - OFF Continue with dir RCS (affected axis)	8	
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	7	EVNT TMR ind - mon for .05 G time .05 G lt - on	1	
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		If no .05 G lt by RET .05 G +3 sec		Backup cue may be obtained from MSFN or CMC.
		EMS MODE - BU		Lift vector lights do not function in EMS BU mode. If RNG indicator not decreasing, EMS ranging capability lost.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		.05 G sw - on (up)		At .05 G +10 seconds, one lift vector light will come on; disregard light.
		EMS ROLL - on (up)		.05 G and EMS ROLL switches should be placed to on simultaneously to minimize roll attitude error.
		Scroll slews to left, RNG ind decr		If scroll slews in one axis (V or G), that axis usable.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		Mnvr to BBA & maintain until range potential guidelines can be interpreted, then null range err using range potential guidelines & EMS RNG ind. While nulling range err, avoid tangency to G on-set lines. Reverse bank angle at RETRB to null lateral range err.	1	BBA is backup bank angle. Disregard corridor lamps (as corridor verification cues) for entry from earth orbit (entry velocity <35K fps). RETRB is retrofire elapsed time to reverse bank.
	8	Go to Earth Ldg Phase (<50K'), 4.16		

SCS ENTRY

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.16 EARTH LANDING PHASE (<50K')		
CDR	50K'	CAB PRESS RELF vlv (2) - BOOST/ENTR (safety latch on)	325	
		Report CM stable		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		CM unstable		
CMP	40K'	RCS CMD - OFF	2	OFF position is momentary.
CDR		APEX COVER JETT pb - push	1	Guarded.
		DROG DPLY pb - push (2 sec after apex cover jett)		Guarded.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	30K'	ELS LOGIC - on (up)		Guarded.
		ELS AUTO - AUTO		
CMP		SEC COOL EVAP - off (ctr)	2	Required only if secondary loop in operation.
		GLY EVAP H2O FLOW - off (ctr)		
	24K'	SCS RCS disable (auto)		
		xxxxxxxxxxxxxxxxx		
		RCS CMD - OFF		OFF position is momentary.
		xxxxxxxxxxxxxxxxx		
		Apex cover jett (auto)		The apex cover will be jettisoned at 24K feet plus 0.4 seconds.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR		APEX COVER JETT pb - push	1	Guarded.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	Drogue chutes deployed (auto)		Drogue parachutes deployed at 24K feet plus 2.0 seconds. The CM may be very unstable until the drogue chutes disreef in ≈11 seconds.
	xxxxxxxxxxxxxxxxxxxxxxx		
	DROG DPLY pb - push	1	Guarded.
	xxxxxxxxxxxxxxxxxxxxxxx		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	If no drogue deployment		
	ELS AUTO - MAN		
	Stab CM with dir RCS		
	5K' MN DPLY pb - push		Guarded.
	ELS AUTO - AUTO		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CMP 23.5K'	Mon CAB PRESS ind - starts incr	2	No increase indicates cabin pressure relief valve failure.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR	If no incr by 17K' rh CAB PRESS RELF vlv - DUMP (safety latch off)	325	RH valve has four positions.
CMP	If still no incr CAB PRESS DUMP vlv - open (CCW)	Side hatch	
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T	STEP PROCEDURE	PANEL	REMARKS
CMP			
10K'	Mn chutes & VHF recovery ant deploy (auto)		Auto deployment occurs between 10,950 and 9,100 feet. Parachutes disreef in ≈15 seconds after pilot mortars fire.
CDR	MN DPLY pb - push (within 1 sec)	1	Guarded. MN DPLY pushbutton should be pushed within 1 second after pilot mortars fire to ensure simultaneous deployment of main parachutes.
	SRG TK O2 vlv - OFF	326	
	REPRESS PKG vlv - OFF		
	DIRECT O2 vlv - OPEN (CCW)	7	
LMP	Set up entry comm		
	VHF ANT - RECY	3	
	VHF AM A - SIMPLEX		If VHF AM B SIMPLEX or VHF AM A DUPLEX required, turn off beacon during period of communication.
	VHF BCN - ON		
CDR	Transmit voice (VHF AM) reporting Position Mn chutes disreefed Splash err Crew stat		Continue voice transmission until touchdown.
CMP	Crew couch struts (4) - unlock		
CDR	CM RCS LOGIC - on (up)	1	Must be on to power CM PRPLNT DUMP switch.
	CAUTION CM PRPLNT DUMP should be init immediately after mn chute disreefing. If mn or pyro bus lost, use RHCs for burn, not CM PRPLNT DUMP sw.		

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	CAB PRESS RELF vlv (2) - CLOSE (safety latch off)	325	
CMP	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - close (CW)	Side hatch	
CDR	CM PRPLNT DUMP - on (up) (dump burn is audible)	1	Guarded.
CMP	RCS IND sel - CM 1 & 2 RCS He PRESS ind - decr	2	
CDR,CMP	No burn or no press decr RHC (both) - fire all RCS jets (except + pitch) until prplnts are depleted		One RHC positioned to command plus yaw and roll (excluding plus pitch) and other RHC positioned to command minus yaw, pitch, and roll.
CDR	When prplnt dump burn completed CM PRPLNT PURG - on (up) (purge is audible)	1	Guarded. Both CM RCS LOGIC and CM PRPLNT DUMP switches must be on (up) to power CM PRPLNT PURG switch. Visible fire from RCS engine nozzle extension surfaces, after burn to depletion and during purge, expected and normal.

EARTH LANDING PHASE (<50K')

STA/T STEP	PROCEDURE	PANEL	REMARKS
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR	CM RCS He DUMP pb - push	1	Guarded. CM RCS He DUMP pushbutton should be used to initiate purge following a normal dump operation if CM PRPLNT PURG switch fails to initiate purge.
CDR,CMP	If RHC (both) used for prplnt dump burn RHC (both) - fire all jets (except + pitch)		One RHC positioned to command plus yaw and roll (excluding plus pitch) and other RHC positioned to command minus yaw, pitch and roll.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CDR	CAB PRESS RELF vlv (2) - BOOST/ENTR (safety latch off)	325	
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CMP	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - open (CCW)	Side hatch	
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	If night ldg		
CDR	cb FLOAT BAG (all) - close	8	
	PL BCN LT - LO	15	The postlanding beacon light has longer operating life in LO.
LMP	cb FLT/PL BAT BUS A, B & BAT C (3) - close	275	Connects battery bus A, B, and battery C to flight and postlanding bus.
	cb FLT/PL MNA & B (2) - open		
CDR	cb SPS PITCH (2) - open	8	
	cb SPS YAW (2) - open		

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	CM RCS PRPLNT (both) - OFF	2	OFF position is momentary. Prevents RCS fume ingestion into cabin at 3K' when CAB PRESS RELF vlv - DUMP.
	CM RCS PRPLNT tb (both) - bp		Barber pole indicates at least one valve (fuel or oxidizer) closed in the particular system 1 or 2.
3K' CDR	rh CAB PRESS RELF vlv - DUMP (safety latch off)	325	Assures minimum cabin-to-ambient negative ΔP for landing impact.
	FLOOD FIXED - POST LDG	8	Provides power from flight and postlanding bus to one floodlight in LH couch area and one floodlight in center couch area. Minimize floodlight use during postlanding. Maximum utilization should be 9.6 hours per 48-hour period.
	FLOOD DIM - 1 or 2		Position 1 provides power to two secondary floodlights and position 2 provides power to two primary floodlights when FLOOD LTS FIXED switch in POST LDG position after dc main buses deactivated.
800'	CAB PRESS RELF vlv (2) - CLOSE (safety latch off)	325	Valves must be closed prior to touchdown to prevent water from entering CM.
CMP	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx x x If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - close (CW) x x xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	Side hatch	
CDR	ELS AUTO - AUTO (verify) ELS LOGIC - on (up) (verify)	1	 Guarded.

EARTH LANDING PHASE (<50K')

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP		MN BUS TIE (2) - OFF	5	Removes battery power from dc main buses.
		CAUTION **MN BUS TIE sws must be left in OFF position to ensure that bats A, B, and C are used to pwr the PL bus only, & to prevent bat shorting caused by water entering the CM feed-thru connectors.**		
		cb BAT RLY BUS (2) - open		
		Postlanding Check, 4.17		

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.17 POSTLANDING		
	4.17.1 POSTLANDING STABILIZATION		
LMP	cb MN REL (2) - close	229	
CMP	MN REL - on (up)	2	Guarded. On position is momentary. Releases main parachutes.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	If no mn chute rel		
CDR	ELS AUTO - AUTO (verify)	1	Switch should have been on at least 14 seconds to allow timer to time out and enable MN REL switch.
	ELS LOGIC - on (up) (verify)		Guarded.
CMP	MN REL - on (up)	2	Guarded. On position is momentary.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	WARNING If fire or smoke after impact, refer to Fire/Smoke in CM During Postlanding, 5.3.3.1.		
CDR	SECS PYRO ARM (2) - SAFE	8	Lever lock.
	SECS LOGIC (both) - OFF		Lever lock.
	If not in contact with recovery forces		
ALL	VHF AM (3) - RCV	9,10,6	
LMP	VHF AM A - off (ctr)	3	
	VHF AM RCV - A		

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	cb PL VENT FLT/PL - close	8	
	cb FLOAT BAG (all) - close		
LMP	cb UPR SYS COMPR (both) - close	278	
	If floating upright		
	CAUTION Wait 10 min prior to init bag fill. This allows the ablator to cool sufficiently prior to inflation. Heat can destroy bags.		
CDR	FLOAT BAG (all) - FILL for 7 min, then OFF	8	Lever lock. Wait 15 minutes prior to running compressors again.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	If floating inverted		
	FLOAT BAG (all) - FILL		Lever lock.
LMP	VHF BCN - OFF	3	
	VHF AM A - off (ctr)		
	Two min after upright		
CDR	FLOAT BAG (all) - OFF	8	Lever lock.
LMP	VHF BCN - ON	3	
	If in contact with recovery forces prior to floating inverted		
	VHF AM A - SIMPLEX		If VHF AM B SIMPLEX or VHF AM A DUPLEX required, turn off beacon during period of communication.

POSTLANDING STABILIZATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If CM fails to upright in 7 min & CM rolls CW		Crew reposition procedures may be required if uprighting does not occur in 7 minutes and sea state is minimal.
CDR		FLOAT BAG 2 R - OFF (Continue uprighting for 8 additional min)	8	Lever lock.
CMP,LMP		If uprighting does not occur in 3 min, reposition to area behind CDR's couch & CMP's couch as near as poss to B3 stowage locker		
	or	CM rolls CCW		
CDR		FLOAT BAG 1 L - OFF (Continue uprighting for 8 additional min)		Lever lock.
CDR,CMP		If uprighting does not occur in 3 min, reposition to area behind LMP's couch & CMP's couch		
	or	No roll		
CDR		FLOAT BAG 3 CTR - OFF (Continue uprighting for 8 additional min)		Lever lock.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP,LMP	If uprighting does not occur in 3 min, reposition to area on top of or along lower equip bay cstr WARNING If CM still does not upright, prepare to egress within 15 min (because of environmental conditions) after completing above uprighting procedure. Refer to Stable II Water Egress Procedure, 4.17.4.3 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.17.2 POST STABILIZATION AND VENTILATION		
ALL	Release footstraps		
	Release restraint harness		
LMP	cb MNA BAT BUS A & BAT C (2) - open	275	
	cb MNB BAT BUS B & BAT C (2) - open		
	cb FLT/PL BAT C - open		Battery C held in reserve for use after depletion of battery A and B charge.
	cb PYRO A/SEQ A - open	250	
	cb PYRO B/SEQ B - open		
	DC IND sel - BAT BUS A,B	3	
	DC VOLTS ind - >27.5 vdc		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	If BAT BUS A(B) <27.5 vdc		
	cb FLT/PL BAT BUS A(B) - open	275	
	Go to Comm Low Pwr Procedures, 4.17.3.3		
	If BAT BUS A & B (2) <27.5 vdc		
	cb FLT/PL BAT BUS A & B (2) - open		
	cb FLT/PL BAT C - close		
	Go to Comm Low Pwr Procedures, 4.17.3.3, & mon BAT C voltage		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
CMP	PLV distribution duct (3) - unstow & install		Stowed in aft bulkhead stowage area.
	Remove debris trap from left X-X head strut at MDC		Allows cabin air to flow to PL valve exhaust port on forward bulkhead.
	PL VENT VLV - PULL (unlock)	2	

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	PL VENT - HI or LO	15	PLV fan can operate in high flow for 12 hours maximum. During periods of no PLV fan operation, cycle PLV 5 minutes every half hour. If RCS fumes are noticed, prepare to egress immediately. PL VENT should be cycled from HI to LO prior to using manual backup procedure.
	xxxxxxxxxxxxxxxxxxxxxxxxxxx If no PLV operation To initially open vlvs PLVC sw - OPEN	376	Prepare to egress CM in 30 minutes after landing if valves cannot be opened.
	To close vlvs PL VENT - OFF	15	
	To reopen vlvs PL VENT - HI or LO xxxxxxxxxxxxxxxxxxxxxxxxxxx		
	PL BCN LT - LO		After dark only. Place switch at HI only at request of recovery forces.
	xxxxxxxxxxxxxxxxxxxxxxxxxxx If no flashing lt		Perform backup duty cycle at request of recovery forces.
	FLOOD FIXED - POST LDG for 1/2 min OFF for 1/2 min xxxxxxxxxxxxxxxxxxxxxxxxxxx	8	
	Deploy dye marker & swimmer umbilical DYE MARKER - on (up)	15	Guarded. On (up) position is momentary.

POST STABILIZATION AND VENTILATION

STA/T	STEP	PROCEDURE	PANEL	REMARKS
ALL		INTERCOM (3) - T/R (verify)	9,10,6	Required for swimmer umbilical operation.
CDR		Deploy line grappling hook (if req) CAB PRESS DUMP vlv - remove Grappling hook & line - deploy thru vlv opening Cover plate - secure	 Side hatch	Grappling hook deployed at request of recovery forces. It is located in aft bulkhead stowage area and is for snagging sea anchors deployed by recovery forces. Adapter E and driver R tools required to remove cabin pressure dump valve and secure cover plate on side hatch (over valve opening).

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.17.3 POSTLANDING COMMUNICATIONS		
	4.17.3.1 Normal Postlanding Communications		
LMP	VHF BCN - ON (verify) VHF ANT - RECY (verify)	3	
	If no contact with recovery forces VHF AM B - SIMPLEX Mon for VHF bcn 1000 Hz tone (2 sec on, 3 sec off) VHF AM B - off (ctr) If VHF bcn not audible Remove survival transceiver from stowage & mount ant Sel VOICE on transceiver Mon VHF bcn for 1000 Hz tone (2 sec on, 3 sec off) If VHF bcn operating Turn off survival transceiver Stow transceiver in RHFEB		Government-furnished survival transceiver stowed in RHFEB.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx If no VHF bcn sig, turn off transceiver, remove ant, & conn transceiver to ant per 4.17.3.2 Sel BCN on transceiver Mon VHF AM for comm initiated by recovery aircraft xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.17.3.2 Survival Transceiver Communications		
LMP	VHF BCN - OFF (if no contact after 24 hours)	3	Conserve spacecraft power for terminal phase of recovery operations.
	Survival transceiver - conn to VHF BCN ant cable		
	Remove survival transceiver from stowage		Transceiver is stowed in RHFEB.
	Unlatch & open VHF ant access door		A 5/32" hex wrench, for opening two hex fasteners on antenna cable access door, stowed in aft bulkhead stowage area.
	Disconnect P112 conn from bcn		An adjustable wrench, stowed in aft bulkhead stowage area, used to loosen 5/8" hex on coax connector.
	Attach transceiver cable P1 conn to transceiver (verify)		
	Conn transceiver cable J1 conn to P112 conn		
	Select BCN on transceiver		
	4.17.3.3 Communications Low Power Procedures		
	VHF BCN - OFF		
CDR	FLOOD FIXED - OFF	8	Turns off postlanding floodlights.
LMP	VHF AM A - off (ctr)	3	
	VHF AM RCV - A		
CDR	PL VENT sys - minimize use		
	Survival transceiver - conn to VHF BCN ant cable (refer to Survival Transceiver Comm, 4.17.3.2)		
	4.17.3.4 Spacecraft Power Down		
	PL VENT - OFF	15	
LMP	cb ENTRY/PL BAT A, B, C (3) - open	250	

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.17.4 UNAIDED EGRESS PROCEDURES		
	4.17.4.1 <u>Egress Preparation</u>		
ALL	Disconnect umbilicals (if suited) Neck dams on (if suited) Configure couch seat pans Center couch - 270° position L & R couch - 270° position (if stable II egress anticipated)		
CDR,LMP	Armrests folded (stowed)		
ALL	If unsuited, transfer scissors from suit to coveralls		Scissors may be required to cut mooring lanyard in an emergency.
	Tape flight penlight to wrist (night egress)		
LMP	Survival kits removed from stowage	R-4	
	Remove lanyards from rucksack kit No. 2 & reclose rucksack		
CMP	Conn liferaft mooring line (olive drab) to CM		
	Conn lanyard titled (attach to first crewman out) to suit (if unsuited attach to buckle on life vest)		
LMP	Conn lanyard titled (attach to second crewman out) to suit (if unsuited attach to buckle on life vest)		
CDR	Conn lanyard titled (attach to third crewman out) to suit (if unsuited attach to buckle on life vest)		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.17.4.2	<u>Stable I Water Egress</u>		
CMP		PL VENT - OFF	15	
LMP		cb ENTRY/PL BAT A, B, C (3) - open	250	
CMP		Charge hatch counterbalance	Side hatch	
		GN2 ratchet handle - opr		
		GN2 vlv handle - unlock and push outboard		
		Open side hatch		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		If side hatch was closed by backup proced in 4.5.7.2, loosen jack-screws by screwing wing nuts CCW		
		Disengage hooks from catches on hatch		
		Disengage jackscrew lever from hatch frame		
		If any hatch latches are latched, complete side hatch opening proced; if not, open hatch		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		Lock pin rel knob - UNLOCK		
		Gear box sel - UNLATCH		
		Actr handle sel - U (unlatch)		
		Actr handle rel - push or squeeze		Push button or squeeze for release on actuator handle for operation.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Actr handle - opr (until hatch can be opened)	Side hatch	
	Push hatch open		
	Actr handle sel - N (neut)		
CDR	Remove life raft from rucksack kit No. 2		
	Simultaneously throw life raft overboard & pull inflation lanyard		
	Throw rucksacks No. 1 & 2 overboard		
	Egress, inflate life vest, board raft		
LMP	Egress, inflate life vest, board raft		
CMP	Egress, inflate life vest, board raft		
	4.17.4.3 <u>Stable II Water Egress</u>		
	PWR (3) - OFF	6,9,10	
	SUIT PWR (3) - OFF		
	PRESS EQUAL vlv - OPEN	Fwd hatch	Pull detent knob on end of handle, then pivot up 90°. Rotate crank ≈3 turns CCW to fully open valve. This will flood tunnel prior to opening hatch.
	<u>WARNING</u> To prevent injury to crew members, do not unlock hatch until flooding stops & press equalizes in CM.		
	Actr handle rel - pull & rotate		To free actuator handle for operation, release rotated to mechanical stop.
	Actr handle - pull to stop		Actuator handle should move ≈80°.
	Actr handle sel - U (unlatch) (CCW 90°)		

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Actr handle - push to stop	Fwd hatch	Actuator handle should move 60° to release hatch.
	Actr handle sel - stow (CW 90°)		
	Actr handle - push to stowed position		
CMP,LMP	Remove & stow fwd hatch		Forward hatch weighs ≈85 lbs and is stowed in LHEB.
CMP	Put survival rucksacks down tunnel		
	Exit feet first; when clear of CM, inflate water wings		
LMP	Exit feet first; when clear of CM, inflate water wings		
CMP,LMP	Remove life raft from rucksack No. 2 & inflate raft		
CDR	Disconnect life raft mooring line (olive drab) from CM & return end of line (CDR's discretion)		
	Exit feet first; when clear of CM inflate water wings		
	Reconnect life raft mooring line (olive drab) to SC exterior - sea anchor hardpoint or EVA handles (CDR's discretion)		
	4.17.4.4 <u>Rough Sea Side Hatch Operations</u>		
CMP	Close side hatch	Side hatch	
	GN2 vlv handle - pull (inboard)		Vents counterbalance piston chamber. Squeeze handle to unlock.
	GN2 press ind - min		
	Open door rel handle - pull		D-ring.
	Verify latches are in open position		
	Close hatch		

Basic Date 17 July 1970 Change Date

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Actr handle sel - L (latch)	Side hatch	
		Gear box sel - LATCH		
		Open door rel handle - stow		
		Actr handle rel - push or squeeze		
		Actr handle - opr (while holding hatch closed)		
		Lock pin rel knob - LOCK (auto)		Verify lock pin has automatically engaged.
		LOCK PIN ind - not extd		Indicates lock pin engaged.
		Actr handle - stowed		
		Re-open side hatch		
		Lock pin rel knob - UNLOCK		Pin can be sheared if left in LOCK position.
		Gear box sel - UNLATCH		
		Actr handle sel - U (unlatch)		
		Actr handle rel - push or squeeze		Push button or squeeze (bar) releases actuator handle for operation.
		GN2 vlv handle - push (outboard)		
		GN2 press ind - green		
		Actr handle - opr (until hatch can be opened)		Actuator handle should not be operated until immediately prior to egress.

UNAIDED EGRESS PROCEDURES

4.18 LUNAR ORBIT EXPERIMENTS

Procedures presented in this section represent a single cycle of each experiment operation. The operational periods will be defined by the mission time line (or flight plan) including status of deployment mechanisms after data collection periods. All experiments except S-band transponder (S164) and Bi-static Radar (S170) require that SIM door be jettisoned prior to conducting experiments. The following matrix identifies experiments having electrical interface with CSM requiring crew participation.

EXP. No.	Name	CSM 112	CSM 113	CSM 114	CSM 115
S160	Gamma Ray Spectrometer	X	X		
S161	X-Ray Fluoresence Spectrometer	X	X		
S162	Alpha-Particle Spectrometer	X	X		
S163	Optical Bar Panoramic Camera	X	X	X	X
S164	S-Band Transponder	X	X	X	X
S165	Mass Spectrometer	X	X		
S166	3-inch Mapping Camera	X	X	X	X
S169	Far Ultra-Violet Spectrometer			X	X
S170	Bi-Static Radar				X
S171	IR Scanning Radiometer			X	X
S173/174	Subsatellite	X		X	X
S175	Laser Altimeter	X	X	X	X

4.18.1 GENERAL OPERATIONAL REQUIREMENTS

The following considerations are applicable to lunar orbit experiment procedures:

1. SM RCS jets A2, A4, B1 and B4 are inhibited during experiment operation to reduce contamination and thermal gradients in the SIM bay after the SIM door is jettisoned. In addition, jets C1 and C3 are inhibited whenever the mass spectrometer boom is deployed.
2. Particle-sensitive experiments should be scheduled as long as possible after ECS dumps and purges to preclude degradation of experimental data.
3. If required during experiment operation, mission time and duration of dumps and purges must be recorded for postflight analysis of experimental data.
4. Local vertical attitude hold will be maintained during experiment operations, except for experiment calibration and possibly for IMU alignments.
5. During spacecraft maneuvers in lunar orbit, direct sunlight impingement into the SIM bay should be avoided to prevent damage to experiments.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.18.2 SIM DOOR JETTISON AND EXPERIMENT TIE-DOWN RELEASE		
	CMC - on (req), 4.8.1.3		
	ISS - on & orient known (req), 4.8.1.3 & 4.14		
	SCS - on (desired), 4.8.4.2		
	RCS DAP - load & activate (req), 4.8.2.1		
	All jets OFF except		Jets are disabled to prevent SIM bay contamination and enables single jet control until SIM experiments completed.
CDR	AUTO RCS B/D ROLL B2 & D1 - MNA or MNB	8	
	AUTO RCS PITCH A3 & C4 - MNA or MNB		
	AUTO RCS YAW B3 & D4 - MNA or MNB		
	Mnvr to jett SIM door R____°, P____°, Y____°		SIM door to impact lunar surface.
LMP	FC REACS VLVS - LATCH	3	Holding voltage prevents SIM door jettison shock from inadvertently closing FC reactants valves.
	Arm SIM door & jett		
CMP	cb LOGIC PWR (2) - close (verify)	181	
	LOGIC PWR - JETT		
	DOOR JETT - on (up)		Guarded - On (up) position momentary.
LMP	FC REACS VLVS - NORM	3	
	Rel booms		
	NONESS BUS - MNA (MNB) (verify)	5	
	cb INST SCI EQUIP (3) - close (verify)		
CMP	SM/AC PWR - on (up), then OFF	181	Releases gamma-ray and mass spectrometer booms and subsatellite launcher tie-downs.
	DOOR JETT - off (down)		Guarded.
	LOGIC PWR - OFF		

STA/T STEP	PROCEDURE	PANEL	REMARKS
	Go to boom & camera/altimeter deploy, 4.18.3.1, 4.18.3.3 & 4.18.3.5 as req		

SIM DOOR JETTISON AND EXPERIMENT TIE-DOWN RELEASE

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.18.3	DEPLOY & RETRACT GAMMA RAY & MASS SPECTROMETER BOOMS & MAPPING CAMERA		
	4.18.3.1	Deploy Gamma Ray Boom		
CMP		cb LOGIC PWR MNA - close (verify)	181	
		LOGIC PWR - DPLY/RETR		
		GAMMA RAY BOOM DPLY - on (up)	230	If gamma-ray spectrometer is to be operated in retracted position, omit this and following step. Maximum continuous operating time in retracted position is 3 hours because of thermal considerations.
		GAMMA RAY BOOM DPLY tb - bp, then gray		Barber pole when boom is in any position except fully extended or retracted. ≈100 seconds required to fully extend boom.
		LOGIC PWR - OFF	181	
	4.18.3.2	Retract Gamma Ray Boom		
		WARNING Boom must be retracted prior to SPS mnvrs or structural failure may result.		
		cb LOGIC PWR MNA - close (verify)		
		LOGIC PWR - DPLY/RETR		
		GAMMA RAY BOOM DPLY - RETR	230	≈100 seconds required to retract boom.
		GAMMA RAY BOOM DPLY tb - bp, then gray		Barber pole when boom is in any position except fully extended or retracted.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	If no boom retract, jett exp pkg prior to SPS thrusting		
CMP	cb LOGIC PWR (2) - close (verify)	181	
	LOGIC PWR - JETT		
	GAMMA RAY BOOM JETT - on (up)	230	On position momentary. Jettisons experiment package.
	GAMMA RAY BOOM JETT tb - bp, then gray		
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	LOGIC PWR - OFF	181	
4.18.3.3	Deploy Mass Spectrometer Boom		
	cb LOGIC PWR MNA - close (verify)		
	LOGIC PWR - DPLY/RETR		
	MASS SPECT BOOM DPLY - on (up)	230	
	MASS SPECT BOOM DPLY tb - bp, then gray		Barber pole while boom is extending. ≈84 seconds required to fully extend boom.
	LOGIC PWR - OFF	181	
4.18.3.4	Retract Mass Spectrometer Boom		
	WARNING Boom must be retracted prior to SPS mnvrs or structural failure may result.		
	cb LOGIC PWR MNA - close (verify)		
	LOGIC PWR - DPLY/RETR		

DEPLOY & RETRACT MASS SPECTROMETER BOOM

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		MASS SPECT ION SOURCE - OFF (verify)	230	Must be OFF when boom is retracted in SIM bay or instrument damage may result.
		MASS SPECT BOOM DPLY - RETR MASS SPECT BOOM DPLY tb - bp, then gray		Barber pole while boom retracting. ≈84 seconds required to fully retract boom.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		If no boom retract, jett exp pkg prior to SPS thrusting		
		cb LOGIC PWR (2) - close (verify)	181	
		LOGIC PWR - JETT		
		MASS SPECT BOOM JETT - on (up)	230	On position momentary.
		MASS SPECT BOOM JETT tb - bp, then gray		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		LOGIC PWR - OFF	181	
	4.18.3.5	<u>Deploy Mapping Camera & Laser Altimeter</u>		
		cb LOGIC PWR MNA - close (verify) LOGIC PWR - DPLY/RETR		
		MAP CAMR TRACK - EXTD	230	
		MAP CAMR TRACK tb - bp, then gray		Barber pole while camera/altimeter extending.
		LOGIC PWR - OFF	181	
	4.18.3.6	<u>Retract Mapping Camera & Laser Altimeter</u>		
		cb LOGIC PWR MNA - close (verify) LOGIC PWR - DPLY/RETR		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		MAP CAMR TRACK - RETR	230	
		MAP CAMR TRACK tb - bp, then gray		Barber pole while camera/altimeter retracting.
		LOGIC PWR - OFF	181	

DEPLOY AND RETRACT MAPPING CAMERA

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.18.4 SIM EXPERIMENTS PREPARATION & SHUTDOWN		
	4.18.4.1 <u>System Preparation</u>		
	CMC - on (req), 4.8.1.3		
	ISS - on & orient known (req), 4.8.1.3 & 4.14		
	SCS - on (desired), 4.8.4.2		
	RCS DAP - load & activate (req), 4.8.2.1		Recommended rates and deadbands - <u>TBD</u>.
	Verify all jets off, except		Jets disabled to prevent SIM bay contamination and maintain balanced SM RCS single jet rotation control until SIM experiments completed.
CDR	AUTO RCS B/D ROLL B2 & D1 - MNA or MNB	8	
	AUTO RCS PITCH A3 & C4 - MNA or MNB		
	AUTO RCS YAW B3 & D4 - MNA or MNB		
	SIM Data Sys Prep		
	Configure TLM, 4.5.6.1, except		
LMP	PCM BIT RATE - HI	3	
	Activate Data Sys		
CMP	DATA SYS ON - ON	230	Allow 15-minute warmup prior to calibration.
	DATA SYS CAL - on (up)		On position (momentary) puts a known calibration signal into voltage control oscillator of FM analog channel. Three-step calibration required.
	Repeat following three times		
	Wait one sec		
	DATA SYS CAL - on (up)		
	4.18.4.2 <u>Systems Shutdown</u>		
	When all SIM exp complete		
	DATA SYS CAL - on (up)		On position momentary.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CMP	Repeat following three times Wait one sec DATA SYS CAL - on (up) DATA SYS ON - OFF	 230	Three-step calibration required prior to shutdown.

SIM EXPERIMENTS PREPARATION & SHUTDOWN

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.18.5 SENSOR CALIBRATION		Performed once each day on lunar darkside by pointing sensor toward deep space. Calibration data obtained by taking background level measurements of deep space.
	Mnvr to calib att R____°, R____°, Y____° Att hold for 15 min Mnvr to exp att Resume exp oper		Roll to point sensor 135°-180° (toward deep space) from local vertical.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.18.6 S160 - GAMMA RAY SPECTROMETER		
		Verify SIM Door Jett, 4.18.2		
		Sys Prep, 4.18.4.1		
		Mnvr to exp att R____°, P____°, Y____° (detector at lcl vert)		Normal lunar orbit operation periods will utilize local vertical mode, with SIM pointing toward moon.
		Establish lcl vert att hold, TBD		
		Deploy Gamma Ray Boom, 4.18.3.1		
		Activate exp		
LMP		cb SCI EQUIP SEB 2 - close (verify)	5	
		NONESS BUS - MNA (MNB) (verify)		
CMP		GAMMA RAY EXP - ON	230	No warmup required.
		GAMMA RAY GAIN - STEP (as req)		STEP position momentary. Increases sensitivity. Positioned per flight plan or as directed by MSFN in real time.
		GAMMA RAY GAIN - ctr		
		Terminate exp		
		GAMMA RAY EXP - OFF		
		If boom to be retracted, refer to 4.18.3.2		Mission time line or flight plan will determine whether boom to be retracted between data collection periods.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	4.18.7 S161 - X-RAY FLUORESENCE SPECTROMETER		
	Verify SIM Door Jett, 4.18.2		
	Sys Prep, 4.18.4.1		
	<u>CAUTION</u> Avoid Sun entering instrument FOV (±30° from SIM pointing line) or instrument will be destroyed. If direct sunlight exposure is anticipated pwr to the instrument must be removed by placing X RAY EXP sw to STBY.		
	Mnvr to exp att R____°, P____°, Y____° (snsr at lcl vert)		Normal lunar orbital operation periods will utilize local vertical mode, with SIM pointing toward moon.
	Establish lcl vert att hold, <u>TBD</u>		
	Open solar snsr door		
LMP	cb SCI EQUIP HATCH - close (verify)	5	
CMP	cb LOGIC PWR MNB - close (verify)	181	
LMP	NONESS BUS - MNA (MNB) (verify)	5	
CMP	LOGIC PWR - JETT	181	
	X RAY DR DPLY - on (up)	230	On position momentary. Opens X-ray solar sensor door. Door not retractable.
	LOGIC PWR - OFF	181	
	Activate exp		
	X RAY EXP - ON	230	No warmup required.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If calib req, refer to 4.18.5		Calibration required once each day.
		To term exp		
CMP		X RAY EXP - OFF	230	

EXPERIMENT S161

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.18.8 S162 - ALPHA PARTICLE SPECTROMETER		
		Verify SIM Door Jett, 4.18.2		
		Sys Prep, 4.18.4.1		
		CAUTION Avoid sun entering instrument FOV (±45° from SIM pointing line), or damage to instrument will result.		
		Mnvr to exp att R____°, P____°, Y____° (snsr at lcl vert)		Normal lunar orbital operation periods will utilize local vertical mode, with SIM pointing toward moon. Limit exposure of detector to direct solar radiation for not more than 5 consecutive minutes with a total exposure time not to exceed 30 minutes.
		Establish lcl vert att hold, TBD		
		Activate exp		
LMP		cb SCI EQUIP HATCH - close (verify)	5	
		NONESS BUS - MNA (MNB) (verify		
CMP		ALPHA RAY - ON	230	Warmup not required.
		If calib req, refer to 4.18.5		Calibration required once each day on lunar dark side.
		To term exp ALPHA RAY - OFF		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.18.9 S163 - OPTICAL BAR PANORAMIC CAMERA		
		4.18.9.1 Panoramic Camera Boost Mode		Boost mode required during boost, TLI and SPS thrusting periods until panoramic camera operations are complete.
	1	Boost Mode On		
LMP		NONESS BUS - MNA (MNB) (verify)	5	
		cb SCI EQUIP SEB 1 & 2 (2) - close (verify)		
CMP		cb SM SECTOR 1 AC2 (3) - close (verify)	181	
		PAN CAMR MODE - STBY (verify)	230	
		PAN CAMR PWR - BOOST		
	2	Boost Mode Off		When thrusting is completed.
		PAN CAMR PWR - off (ctr)		
		SM/AC PWR - OFF	181	
		4.18.9.2 Panoramic Camera Standby Mode		
	1	Stby Mode On		
LMP		NONESS BUS - MNA (verify)	5	
		cb SCI EQUIP SEB 1 - close (verify)		
CMP		cb SM SECTOR 1 AC2 (3) - close (verify)	181	
		SM/AC PWR - on (up) (verify)		
		PAN CAMR PWR - ON	230	
		PAN CAMR MODE - STBY (verify)		
		PAN CAMR SELF TEST - off (ctr)		
	2	Stby Mode Off		
		PAN CAMR PWR - off (ctr)		

EXPERIMENT S163

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.18.9.3	Panoramic Camera Heater Mode		≈10 hours of warmup time in heater mode required before camera operation.
	1	Htr Mode On		
LMP		NONESS BUS - MNB	5	
		cb SCI EQUIP SEB 1 - close (verify)		
CMP		SM/AC PWR - on (up) (verify)	181	
		PAN CAMR SELF TEST - HTRS	230	
	2	Htr Mode Off		
		PAN CAMR SELF TEST - off (ctr)		
	4.18.9.4	Panoramic Camera Self Test		Panoramic camera must be operated every 24±6 hours to prevent film set. Panoramic camera self-test or camera operation will satisfy this requirement.
LMP		NONESS BUS - MNA (verify)	5	
		cb SCI EQUIP SEB 1 - close (verify)		
CMP		cb SM SECTOR 1 AC2 (3) - close	181	
		SM/AC PWR - on (up) (verify)		
		PAN CAMR MODE - STBY (verify)	230	
		PAN CAMR PWR - ON		
		PAN CAMR SELF TEST - on (up)		On position momentary.
		PAN CAMR OPR tb - bp to gray		Barper pole until completion of five test frames; if barber pole remains, panoramic camera no-go.
		At completion of self-test		
		PAN CAMR PWR - off (ctr)		
		SM/AC PWR - OFF	181	
	4.18.9.5	Panoramic Camera Operation		
		Verify SIM Door Jett, 4.18.2		
		Sys Prep, 4.18.4.1		0.5° attitude and 0.05°/sec rate deadbands for this experiment.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	Mnvr to exp att R____°, P____°, Y____°		Normal lunar orbital operation periods will utilize local vertical mode, with SIM pointing toward moon. ±0.5° attitude hold deadband is recommended in roll and yaw. Camera is direction-sensitive; plus X-axis into velocity vector.
	Verify gamma-ray & mass spectrometer booms retracted, 4.18.3.2 & 4.18.3.4		Photo degradation will result if gamma-ray and mass spectrometer booms extended.
	Pan Camr Htr Mode On, 4.18.9.3, step 1		≈10 hours of warmup time in heater mode required before camera operation.
	Pan camr oper		
	Change oper modes (htr to stby)		
LMP	NONESS BUS - MNA	5	These steps represent the delta between modes.
CMP	cb SM SECTOR 1 AC2 (3) - close	181	
	SM/AC PWR - on (up)		
	PAN CAMR SELF TEST - off (ctr)	230	
	Start pan camr		
	PAN CAMR MODE - OPR		Camera starts operating. Camera operation limited to 20 minutes.
	PAN CAMR OPR tb - bp, then gray		Talkback gray after 2 seconds and remains gray. If barber pole appears, camera not operating.
	Stop pan camr		
	PAN CAMR MODE - STBY		
	PAN CAMR PWR - off (ctr)		
	SM/AC PWR - OFF	181	
	EVA req for film cassette retrieval, 4.10.3		Film cassette retrieved during TEC. Cassette is 19 inches in diameter 7 inches wide and weighs ≈88 pounds.

STA/T	STEP	PROCEDURE	PANEL	REMARKS

4.18.10 S164 - S-BAND TRANSPONDER

The S-band transponder experiment is conducted with a solo CSM in lunar orbit (LM on lunar surface). The experiment consists of a data collection period of two lunar revolutions with the number of data collection periods dependent upon CSM orbit inclination. During each experimental period, MSFN will track CSM while it is being held in a G&N attitude hold (minimum deadband). This hold will be maintained by SM RCS jets operating in balanced couples, minimizing high gain antenna motion relative to MSFN tracking stations, and should be completed prior to SIM door jettison to avoid SIM bay contamination. Also, to prevent unnecessary motion during the experiment, H20 boiler operation, purges, water dumps, etc., will be avoided.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	CMC - on (req), 4.8.1.3		
	ISS - on & orient known (desired), 4.8.1.3 & 4.14		
	SCS - on (desired), 4.8.4.2		
	RCS DAP - load & activate (req), 4.8.2.1		0.5° attitude deadband and 0.5°/sec rates are recommended.
CDR	AUTO RCS (16) - as req	8	
	Mnvr to exp att		
	R____°, P____°, Y____°		
	Sel telecom basic config, 4.5.6.1		
	except		
LMP	PCM BIT RATE - HI	3	

STA/T STEP	PROCEDURE	PANEL	REMARKS

4.18.11 S165 - MASS SPECTROMETER

Operational Requirements

- Prior to initial operation in lunar orbit, the mass spectrometer must have accumulated 6 hours of warmup operation with its boom extended. If dumps or boom retractions occur during the 6-hour period, each dump or retraction will necessitate an additional 1/2-hour warmup. Additionally, at least 1 hour of uninterrupted warmup is required immediately prior to data collection. Subsequent lunar orbit operations require 30-minute warmup periods. Prior to TEC operations, a 3-hour warmup is required. The same continuity and interference constraints imposed on lunar orbit warmup apply to TEC warmup.
- In lunar orbit, a minimum of three data collection periods of at least two revolutions per collection period are required. During each of the three periods the minus X-axis of the CSM will be aligned to the velocity vector. Additionally, a minimum of one revolution is required while the CSM plus X-axis is aligned to the velocity vector.
- Data collection during TEC should not begin within 6 hours of an SPS or RCS translation burn.

4.18.11.1 Mass Spectrometer Operation

PROCEDURE	REMARKS
Verify SIM Door Jett, 4.18.2 Sys Prep, 4.18.4.1 Mnvr to exp att R____°, P____°, Y____° Xsc aligned along velocity vctr & detector at lcl vert Initiate orb rate TBD Deploy Mass Spect Boom, 4.18.3.3	Normal lunar orbital operation periods will utilize local vertical mode, with SIM pointing toward moon.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	Warmup		
LMP	cb SCI EQUIP SEB 1 - close (verify)	5	
	NONESS BUS - MNA (MNB) (verify)		
CMP	MASS SPECT EXP - STBY	230	Prior to initial operation, mass spectrometer must have accumulated 6 hours of warmup operation (boom extended) with MASS SPECT EXP and MASS SPECT ION SOURCE switches at STBY. If dumps or boom retractions occur during the 6-hour period, each dump or retraction will necessitate an additional 1/2 hour of warmup. Additionally, at least one hour of uninterrupted warmup is required immediately prior to data collection. Subsequent lunar orbit operations require 30 minute warmup periods.
	MASS SPECT ION SOURCE - STBY (wait 30 min)		
	Activate exp		
	MASS SPECT EXP - ON		
	MASS SPECT ION SOURCE - ON		
	MASS SPECT MULT - as req		MASS SPECT MULT and MASS SPECT DSCRM switches positioned per flight plan or as directed in real time by MSFN.
	MASS SPECT DSCRM - as req		
	Term exp		
	If in lunar orb		
	MASS SPECT ION SOURCE - OFF		
	MASS SPECT EXP - off (ctr)		
	If boom to be retracted, refer to 4.18.3.4		The mission timeline or flight plan will determine whether boom is to be retracted between data collection periods.
	or If in transearth coast		
	MASS SPECT BOOM DPLY - RETR for 20 sec then off (ctr)		Boom retracted in five stages. Assumes 3 ips retract rate.
	MASS SPECT BOOM DPLY tb - gray (wait 7 min)		While boom is in motion, tb is bp.

STA/T STEP	PROCEDURE	PANEL	REMARKS
	Repeat above seq 3 times		
CMP	MASS SPECT BOOM DPLY - RETR	230	
	MASS SPECT BOOM DPLY tb - bp, then gray		Gray tb while DPLY switch is in RETR indicates experiment is fully retracted.
	MASS SPECT BOOM DPLY - off (ctr) (wait 7 min)		
	MASS SPECT ION SOURCE - OFF		
	MASS SPECT EXP - off (ctr)		
or	If no boom retract, refer to backup, 4.18.3.4		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.18.12 S166 - THREE INCH MAPPING CAMERA		
		4.18.12.1 <u>Mapping Camera Cycling</u>		After film has been loaded, camera must be cycled every 24±6 hours to prevent film set.
		Mapping Camr Stby Mode On, 4.18.12.2, step 1		
CMP		MAP CAMR ON - ON (for 2 min), then STBY	230	2 minutes cycles film five frames.
		Mapping Camr Stby Mode Off 4.18.12.2, step 2		
		4.18.12.2 <u>Mapping Camera Standby Mode</u>		
	1	Stby Mode On		Standby mode required during boost, TLI, and SPS thrusting periods until cassette recovery. Standby may be required for 25 hours (worst cold case) prior to initial operation. SIM door may be on or off during the warmup period; camera should be retracted. Note: if hot condition (worst case) the camera should be extended for cool down.
LMP		NONESS BUS - MNA (MNB) (verify)	5	
		cb SCI EQUIP-SEB 2 - close (verify)		
CMP		cb LOGIC PWR MNB - close (verify)	181	
		cb SM SECTOR 1 AC2 (3) - close (verify)		
		SM/AC PWR - on (up)		
		MAP CAMR ON - STBY	230	
		<u>CAUTION</u> The following seq must be performed to prevent loss of GN2. Loss of GN2 results in film degradation.		
	2	Stby Mode Off		When thrusting complete.
		MAP CAMR ON - OFF		
		SM/AC PWR - OFF (if pan camr not in oper)	181	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.18.12.3 <u>Mapping Camera Operation</u>		Operation is direction sensitive with plus X-axis into velocity vector.
		Verify SIM Door Jett, 4.18.2		
		Sys Prep, 4.18.4.1		
		Mnvr to exp att R____°, P____°, Y____°		
		Initiate orb rate		
		Verify gamma-ray & mass spectrometer booms retracted, 4.18.3.2 & 4.18.3.4		Photo degradation will result if the gamma ray and mass spectrometer booms remain extended.
		Extd mapping camr, 4.18.3.5		
CMP		LASER ALTM - ON	230	
		Mapping Camr Stby Mode On, 4.18.12.2, step 1		
		Start mapping camr MAP CAMR ON - ON MAP CAMR IMAGE MTN - as req		Switch position per flight plan or as directed in real time by MSFN.
		Stop mapping camr MAP CAMR ON - STBY		
		Mapping Camr Stby Mode Off, 4.18.12.2, step 2 LASER ALTM - OFF		
		EVA req for film cassette retrieval, 4.10.3		Film cutter is manually triggered during EVA.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	4.18.13	S173/S179 - SUBSATELLITE		
		SIM Door Jett, 4.18.2 (verify)		
		Sys Prep, 4.18.4.1		
		Mnvr to subsatellite launch att R____°, P____°, Y____°		
CMP		cb LOGIC PWR MNA (MNB) - close (verify)	181	
		Report to MSFN		
		After Go From MSFN		
		LOGIC PWR - JETT		
		SUB SAT - LAUNCH	230	SUB SAT tb is gray, then bp for 20 seconds, and returns to gray
		After SUB SAT tb returns to gray		
		SUB SAT - off (ctr)		
		LOGIC PWR - off (ctr)	181	

4.18.14 S169 - FAR ULTRA-VIOLET SPECTROMETER

The far ultra-violet spectrometer is used to determine the composition & density of the lunar atmosphere.

4.18.14.1 Far Ultra-Violet Spectrometer Operation (TBD)

4.18.15 S171 - INFRA-RED SCANNING RADIOMETER

The infra-red scanning radiometer is used to locate and identify, for study, irregularly hot and/or cold regions of the lunar surface that are not illuminated.

4.18.15.1 Infra-Red Scanning Radiometer Operation (TBD)

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.18.16 S175 - LASER ALTIMETER		
		The laser altimeter provides precise time-correlated altitude information for use in conjunction with tracking data and pictures taken by mapping camera, 4.18.12, and panoramic camera, 4.18.9. CSM pointing altitude should be maintained within ±2 degrees of nadir with a maximum drift rate of 0.05 degree-per-second during data collection.		
		4.18.16.1 Independent Operation of Laser Altimeter		
	1	Start Laser Altm		
		Verify that instrument temps lie between TBD & TBD		Laser cavity temperature critical.
		Deploy mapping camr sys, 4.18.3.5		
CMP		LASER ALTM - ON	230	In the automatic mode, the laser altimeter is not slaved to the mapping camera and it cycles once every 20 seconds.
	2	Stop Laser Altm		
		LASER ALTM - OFF		

STA/T STEP	PROCEDURE	PANEL	REMARKS

4.18.17 S170 - DOWNLINK BI-STATIC RADAR OBSERVATIONS OF MOON

This experiment will utilize CSM S-band and VHF-AM transmitters as lunar orbiting radar beacons, and will be conducted during the front side pass of lunar orbits which are visible to Goldstone and Stanford facilities. The experiment period is divided into two phases: Phase A is initiated when the CSM crosses earth-moon line of centers and terminates when the CSM has traversed 120° west longitude; phase B is initiated when the CSM is at 120° east longitude and terminates when the CSM crosses earth-moon line of centers. It is highly desirable that both the S-band and VHF aspect of the experiment be conducted simultaneously. Operation of either or both experiments during additional passes is also highly desirable.

4.18.17.1 S-Band Experiment Operation

The reflected signal from the lunar surface and diverted signal from the back lobe of the CSM high-gain antenna will both be received by 210-foot Goldstone antenna. The S-band high-gain antenna is positioned to a predetermined orientation relative to CSM axes and the CSM is maneuvered such that the reflected beam will be parallel to earth-moon line of centers and the CSM will not occlude high-gain antenna during experiment. There is no modulation of downlink carrier. CSM voice and LBR PCM will be recorded during the experiment for dump to MSFN after experiment phase.

STA/T STEP	PROCEDURE	PANEL	REMARKS
1	CSM att cont CMC - on (req), 4.8.1.3 ISS - on & orient known (desired), 4.8.1.3 & 4.14 SCS - on (desired), 4.8.4.2 RCS DAP - load & activate (req), 4.8.2.1		
	Mnvr to exp att R____°, P____°, Y____		MSFN will provide initial CSM attitude.
	Initiate orb rate		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	2	Sel telecom basic config, 4.5.6.1, except		
ALL		S BD (3) - RCV	9,10,6	
LMP		S BD MODE PCM - ctr	3	
		S BD MODE RNG - OFF		
		S BD AUX TAPE - DN VOICE BU		
		S BD ANT OMNI - HI GAIN		
	3	HGA		
CMP		HI GAIN ANT TRACK - MAN	2	
		HI GAIN ANT SERVO - PRIM		
		HI GAIN ANT BEAM - WIDE		
		HI GAIN ANT PWR - on (up)		
		HI GAIN ANT PITCH & YAW cont (2) - set in req coords		MSFN will provide antenna coordinates.

4.18.17.2 VHF AM Experiment Operation

The reflected signal from the lunar surface and direct signal from the CSM VHF scimitar antenna will be received by 150-foot Stanford antenna. The CSM attitude will be that which is optimum for S-band experiment. One of two VHF scimitar antennas will be selected to provide favorable reception. This experiment will not be conducted during lunar surface EVA.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	1	CSM att cont, 4.18.15.1, step 1		
	2	Sel telecom basic config, 4.5.6.1, except		
ALL		VHF AM (3) - RCV	9,10,6	
LMP		VHF AM A - off (ctr)	3	
		VHF AM B - DUPLEX		
		VHF RNG - on (up)		
		VHF ANT - as req		

EXPERIMENT S170

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		4.19 CAMERA SUPPORT PROCEDURES		
		4.19.1 HASSELBLAD ELECTRIC CAMERA - 70mm		
CMP	1	Set up camr for oper Unstow camr, mount bracket, intervalometer, T-cable & associated compnts Intervalometer sw - OFF (verify) Install camr at window position Connect T-cable to pnl & camr	227	Connection is for PCM signal only. Camera is powered by self-contained battery.
		Connect intervalometer to T-cable		
	2	Dismantle camr setup At completion of camr oper Intervalometer sw - OFF (verify) Disconnect T-cable at pnl & camr Remove camr, mount bracket, & intervalometer & stow all equipment		
		4.19.2 DATA ACQUISITION CAMERA - 16mm		
	1	Set up camr for oper Unstow camr, mount bracket, pwr cable & associated compnts		
		UTIL PWR - OFF (verify) (on pnl selected for pwr source)	15,16,100	Power cable may be connected to panel 15, 16, or 100.
		Install camr at desired location		Includes right-angle mirror.
		Connect pwr cable to camr & pnl UTIL PWR - on (up)		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	2	Dismantle camr setup At completion of camr oper UTIL PWR - OFF Disconnect pwr cable from camr & pnl Remove camr & mount bracket & stow all equipment	 15,16,100	

CAMERA SUPPORT PROCEDURES

SECTION 5
CONTINGENCY PROCEDURES

INTRODUCTION

Contingency procedures consist of operational and trajectory analysis for situations other than normal that may occur during all mission phases. This will provide the crew with decision-making guidance as to aborting the mission, selecting and implementing an alternate mission, or continuing the mission under degraded conditions. The procedures include the corrective action that must be taken and the limitations that may be imposed. Contingency procedures consist of the following:

- Abort procedures. These procedures may be considered as a specialized form of backup procedures which involve early mission termination.
- Malfunction procedures. These procedures encompass the recognition, diagnosis, and corrective action for system malfunctions.
- Emergency procedures. These procedures are another form of backup procedures where safety of the flight crew requires instant action (other than an abort).

5.1 ABORT PROCEDURES

During the ascent phase, an abort can be accomplished in an LES, RCS, or SPS mode. An abort in the LES mode is accomplished by utilizing the launch escape system, which has solid propellant motors mounted on a tower above the command module. During a normal mission, the launch escape tower is jettisoned approximately 36 seconds after second-stage booster ignition. After launch escape tower jettison, an abort can be accomplished in the RCS or SPS mode by utilizing the SM RCS to attain a safe separation distance from the SIVB. The SPS engine is then used, as needed, to correct trajectory for the desired landing site, or insert the CSM into earth orbit.

5.1.1 LES ABORT MODES

An abort may be initiated automatically by the emergency detection system (EDS) when two L/V engines fail, L/V excessive rates detected, breakup between IU and CM, or manually when the commander's translation control is rotated to the full CCW position. Upon receipt of an abort signal, regardless of its source, the booster is cut off (if after T +30 seconds), the CM is separated from the SM, and simultaneous ignition of the launch escape and pitch control motors takes place. Firing of the pitch control motor is inhibited 42 seconds after lift-off. Cutoff of the booster engines is inhibited for the first 30 seconds after lift-off by circuitry in IU because of range safety restrictions. The LES motors provide thrust to propel the command module away from the launch pad or trajectory of the launch vehicle.

Certain events that occur during an abort are controlled automatically by controllers in the sequential events control system (SECS). The earth landing sequence controller (ELSC) contains high-altitude and low-altitude baroswitches. The opening of these baroswitches inhibit ELS operations and the closing initiates the operations. The high-altitude baroswitch controls automatic LES tower jettison, apex cover jettison, and drogue parachute mortar fire. The high-altitude baroswitch is designed to open at 38,500 feet and close at 24,000 feet. Because of venting lag, the high-altitude baroswitch will not open until 40,500 feet during ascent. On an abort initiated under 30,000 feet (low part of abort mode I-B), the 24K feet baroswitch will remain closed and allow automatic LES tower jettison, apex cover jettison, and drogue parachute and main parachute

deployment on a timed sequence controlled by time-delay relays. On an abort initiated between 30,000 feet and 3 minutes 18 seconds, automatic LES tower jettison, apex cover jettison, and drogue parachute deployment are delayed until the command module descends to the closing altitude of the high-altitude baroswitch (24,900 to 21,500 feet).

The low-altitude (10K') baroswitch is closed at 10,000 feet, open at 18,000 feet. Opening of the low-altitude baroswitch will delay automatic deployment of the pilot-main parachutes until the command module descends to the closing altitude (10,950 to 9100 feet).

The LES abort is divided into three different modes as follows:

- Mode 1-A (launch pad to 42 seconds)
- Mode 1-B (42 seconds to 1 minute 56 seconds)
- Mode 1-C (1 minute 56 seconds to LES tower jettison)

During a Mode 1-A abort, CM RCS oxidizer automatically dumps overboard through a hole in the aft heat shield. CM RCS fuel automatically dumps overboard through another hole in the aft heat shield 5 seconds after oxidizer dump started, and requires about 11 seconds for depletion. CM RCS helium automatically begins purging the system 13 seconds after fuel dump started.

During a Mode 1-B or Mode 1-C abort after the main parachutes disreef, manual initiation fires 10 CM RCS jets to expend all propellant, followed by manually initiated helium expenditure through the jets to purge the system.

The two engines out, LV rates, and auto abort capability is switched off prior to S-1C/S-II staging, and the crew must be ready to manually initiate an abort if these conditions arise. During a Mode 1-C abort (over 100K'), it is possible to jettison the LET and accomplish a normal entry provided certain conditions prevail. There must be sufficient TFF (100 sec) to perform the entry maneuver, a reliable attitude reference, and launch escape vehicle (LEV) rates must be within tolerance. If any of these conditions are not met, the LET must be retained to ensure capture of

the LEV with the heat shield oriented forward. The altitude and velocity of the LEV is such that a possibility exists that it could enter the atmosphere canard and escape tower forward. The LEV would remain in this condition until descending below 100,000 feet and Mach 3.8. At this time a fast turnaround would occur which would be detrimental to crew safety. The crew will prevent canard forward capture by manual intervention shortly after abort initiation. A positive pitch rate of over 5° per second will be commanded and maintained until the canard starts trailing the CM upon descending to an altitude under 100,000 feet. Escape tower jettison and ELS activation will automatically occur at approximately 24,000 ft provided that the ELS AUTO sw is in the AUTO position.

The ELS decelerates the CM to a safe touchdown speed. Crew couch attenuators reduce the touchdown impact and start operating at approximately 15 G when they are unlocked. If they are not unlocked, a pin will shear in the lock at approximately 21 G and allow them to operate.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		5.1.1.1 Mode 1A LES Abort (00:00 - 00:42)		
CDR	1	Abort initiation auto or man THC - CCW		If manual backup required for any auto event after abort initiation it must be performed after LE motor burnout (abort T +00:05) because of high G environment during LE motor burn.
CMP		CM/SM SEP (both) - on (up)		Guarded. On position is momentary. If abort is initiated with CM/SM SEP switches, subsequent events may require manual initiation and must be performed after LE motor burnout.
		BECO (auto after T +00:30)	Request grd cmd BECO	
00:00		Evnt Tmr rset & counting up (auto)		
		CM/SM deadface (auto)		
		SM C/W lts - on		Because of switching transients, AC BUS 1 and 2 C/W lights will go on and MN BUS A and MN BUS B UV lights might go on if abort initiated prior to T -01:00.
		MASTER ALARM pb/lt - on		

ABORT

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		CM RCS press (auto)		
		RCS cont trnfr (auto)		
		Entry bats to mn buses (auto if abort init prior to T -01:00)		MN BUS TIE switches set to AUTO by T -30:00 and then to ON at T -01:00. DC main buses must be energized to provide power for RCS transfer, propellant dump, and purge.
		CM RCS oxid dump (auto)		
		CM RCS isolation vlvs close (auto)		
00:00.1		CM/SM sep (auto)		
		LE & PC mot fire (auto)		
00:01.8		CM/SM sep pyro deadface (auto)		
00:05		CM RCS fuel dump (auto)		
		If abort init with CM/SM SEP (both) or BU req for any auto evnt		

LES ABORT MODE IA

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		X EVNT TMR RSET - RSET X		RSET position is momentary.
		X EVNT TMR START - START X		START position is momentary.
CMP		X CM RCS PRESS - on (up) X		Guarded. On position is momentary.
		X RCS TRNFR - CM X		CM position is momentary.
LMP		X MN BUS TIE (2) - on (up) X		
CMP		X Verify PRPLNT DUMP - X AUTO X		
		X CM RCS PRPLNT (both) - OFF X		OFF position is momentary.
CDR		X LES MOT FIRE pb - push X XXXXXXXXXXXXXXXXXXXXXXXXXX X		Guarded. Pitch control motor will not fire if LES MOT FIRE pushbutton used as backup 1.8 sec after abort initiation.
00:11		Canard deploy (auto) X X X X X X	No BU req on Mode 1A	CNRD DPLY pushbutton should not be used as backup on Mode 1A. Since adverse attitudes and critical timing is involved, canard deployment at wrong time could be detrimental to crew safety. Launch escape vehicle will operate satisfactorily without canard deployment.
CMP	2	C/W CSM - CM X X		Extinguishes all SM C/W lights and enables CM RCS C/W lights.
	3	MASTER ALARM pb/lt - push X X		

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR 00:14		ELS logic arm (auto)	X		
	4	ELS LOGIC - on (up)	X		Guarded.
		LES TWR jett (auto)	X		
CMP	a.	Docking ring sep	X	CSM/LM FNL SEP (both) - on (up)	Guarded. On position is momentary.
	b.	TWR attach nuts detonate	X	TWR JETT (both) - on (up)	Guarded. On position is momentary.
	c.	SCS RCS disable	X	RCS CMD - OFF	OFF position is momentary.
	d.	TWR jett mot fire	X		
CDR 00:14.4		Apex cover jett (auto)	X	APEX COVER JETT pb - push	Guarded.
00:16		Drogue chutes deploy (auto)	X	DROG DPLY pb - push (2 sec after apex cover jett)	Guarded.
		WARNING	X		
		Below alidade marker on altimeter, MN DPLY pb - push	X	Altitude = 0.4 NM	

LES ABORT MODE IA

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR 00:18		CM RCS helium purge (auto)	CM RCS He DUMP pb - push	Guarded.
			CM PRPLNT DUMP - on (up)	Guarded. CM PRPLNT DUMP and PURG switches provided alternate means of initiating He dump.
			CM PRPLNT PURG - on (up)	Guarded.
≥10K'		Main chutes & VHF recovery ant deploy (auto)		Main parachutes disreef in ≈15 seconds.
	5	MN DPLY pb - push (within 1 sec)		Guarded. MN DPLY pushbutton should be pushed within 1 second after pilot chute mortars fire to ensure simultaneous deployment of main parachutes.
LMP	6	Set up entry comm VHF ANT - RECY VHF AM A - SIMPLEX VHF BCN - ON		If VHF AM B SIMPLEX or VHF AM A DUPLEX required, turn off beacon during period of communication.
CDR		Xmit voice (VHF AM) reporting Position Mn chutes disreefed Splash err Crew status		Continue voice transmission until touchdown.
CMP	7	Crew couch struts (4) - unlock		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP	8	cb FLT/PL BAT BUS A, B & BAT C (3) - close	X X X X	Connects battery bus A, B, and battery C to flight and postlanding bus.
	9	cb FLT/PL MNA - open	X X	
	10	cb FLT/PL MNB - open	X X	
	11	cb RAD HTRS OVLD (2) - open	X X X	
CDR	12	cb SPS PITCH (2) - open	X X	
	13	cb SPS YAW (2) - open	X X	
3K'	14	rh CAB PRESS RELF vlv - DUMP (safety latch off)	X X X X	Assures minimum cabin-to-ambient negative ΔP for landing impact.
CDR	15	FLOOD FIXED - POST LDG	X X X X	Provides power from flight and postlanding bus to one floodlight in LH couch area and one floodlight in center couch area.
	16	FLOOD DIM - 1 or 2	X X X X X	Position 1 provides power to two secondary floodlights, and position 2 provides power to two primary floodlights when FLOOD FIXED switch is in POST LDG position and dc main buses are deactivated.
CMP	17	Verify RCS IND sel - CM 1	X X	Provides means of monitoring He pressure.

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR			X		
800'	18	CAB PRESS RELF vlv (2) -	X		Valves must be closed prior to touchdown to prevent
		CLOSE (safety latch	X		water from entering CM.
		off)	X		
			X		
	19	ELS LOGIC - on (up)	X		
		(verify)	X		
			X		
CMP	20	CM RCS PRPLNT (both) -	X		OFF position is momentary.
		OFF	X		
		CM RCS PRPLNT tb	X		Barber pole indicates at least one valve closed in
		(both) - bp	X		each system.
			X		
CDR	21	DIRECT O2 vlv - OPEN	X		
		(CCW)	X		
			X		
LMP	22	MN BUS TIE (2) - OFF	X		Removes battery power from dc main buses.
			X		
		CAUTION	X		
			X		
		Sw must be left in OFF	X		
		position to ensure that	X		
		bats A, B & C are used	X		
		to pwr postlanding sys	X		
		only, & to prevent bat	X		
		shorting caused by	X		
		water entering CM feed-	X		
		thru conn.	X		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP	23	cb BAT RLY BUS (2) - open	X X X	
	24	Postlanding check, 4.17	X	

LES ABORT MODE IA

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		5.1.1.2 Mode 1B LES Abort (00:42 - 01:56)		
CDR	1	Abort initiation auto or man THC - CCW		If manual backup required for any auto event after abort initiation, it must be performed after LE motor burnout (abort T +00:05) because of high G environment during LE motor burn.
CMP		CM/SM SEP (both) - on (up)		Guarded. On position is momentary. If abort initiated with CM/SM SEP switches, subsequent events may require manual initiation and must be performed after LE motor burnout.
		BECO (auto)	Request grd cmd BECO	
00:00		Evnt Tmr rset & counting up (auto)		
		CM/SM deadface (auto)		
		SM C/W lts - on		
LMP		MASTER ALARM pb/lt - on		
CDR		CM RCS press (auto)		

ABORT

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	RCS cont trnfr (auto)		
00:00.1	CM/SM sep (auto)		
	LE motor fire (auto)		
00:01	SCS/RCS enbl (auto)		
00:01.8	CM/SM sep pyro dead-face (auto)		
00:05	If abort init with CM/SM SEP (both) or BU req for any auto evnt		
	EVNT TMR RSET - RSET		RSET position is momentary.
	EVNT TMR START - START		START position is momentary.
CMP	CM RCS PRESS - on (up)		Guarded. On position is momentary.
	RCS TRNFR - CM		CM position is momentary.
CDR	LES MOT FIRE pb - push		Guarded.
CMP	RCS CMD - ON		ON position is momentary.

LES ABORT MODE IB

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR 00:11		Canard deploy (auto)	CNRD DPLY pb - push	Guarded.
CMP	2	C/W CSM - CM		Extinguishes all SM C/W lights and enables CM RCS lights.
LMP	3	MASTER ALARM pb/lt - push		
CDR 00:14		ELS logic arm (auto)	ELS LOGIC - on (up)	Guarded.
24K'		LES TWR jett (auto)		
CMP		a. Docking ring sep	CSM/LM FNL SEP (both) - on (up)	Guarded. On position is momentary.
		b. TWR attach nuts detonate	TWR JETT (both) - on (up)	Guarded. On position is momentary.
		c. SCS RCS disable	RCS CMD - OFF	OFF position is momentary.
		d. TWR jett mot fire		
CDR		Apex cover jett (auto)	APEX COVER JETT pb - push	Guarded.
		Drogue chutes deploy (auto)	DROG DPLY pb - push (2 sec after apex cover jett)	Guarded.

5.1.1.2

LES ABORT MODE IB

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR			X		
23.5K'	4	Mon CAB PRESS ind - starts incr	X	If not incr by 17K' rh CAB PRESS RELF vlv - DUMP (safety latch off)	No increase indicates cabin pressure relief valve failure.
CMP			X	If still no incr CAB PRESS DUMP vlv - open (CCW)	
10K'		Mn chutes & VHF recovery ant deploy (auto)	X		Auto deployment occurs between 10,950 feet and 9,100 feet. Parachutes disreef in ≈15 seconds.
CDR	5	MN DPLY pb - push (within 1 sec)	X		Guarded. MN DPLY pushbutton should be pushed within one second after pilot chute mortars fire to ensure simultaneous deployment of main parachutes.
		CAUTION CM PRPLNT DUMP should be init immediately after mn chute disreefing. If mn or pyro bus lost, use RHCs for burn, not CM PRPLNT DUMP sw.	X		
CMP	6	CAB PRESS RELF vlv (2) - CLOSE (safety latch off)	X	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - close (CW)	

LES ABORT MODE IB

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR	7	CM PRPLNT DUMP - on (up) (dump burn is audible)	X X X		Guarded.
CMP	8	RCS IND sel - CM 1 CM RCS He PRESS ind - decr	X X X X X X	RCS IND sel - CM 2 CM RCS He PRESS ind - decr If not decr or RCS jets not firing	
CDR,CMP			X X X X X X X X	RHC (both) - Fire all RCS jets (except plus pitch) until prplnts are depleted	One RHC positioned to command plus yaw and roll (excluding plus pitch) and other RHC positioned to command minus yaw, pitch and roll.
LMP	9	Set up entry comm VHF ANT - RECY VHF AM A - SIMPLEX VHF BCN - ON	X X X X X		If VHF AM B SIMPLEX or VHF AM A DUPLEX required, turn off beacon during period of communication.
CDR		Xmit voice (VHF AM) reporting Position Mn chutes disreefed Splash err Crew status	X X X X X X X		Continue voice transmission until touchdown.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	10	Crew couch struts (4) - unlock	X X X	
	11	Grd track determination	X X	
		a. Key V37E 21E	X X	
		b. FL V04 N06 Option code 00002 CMC assumed option 0000X Verify R2 = 00001 PRO	X X X X X X X X	
		c. FL V06 N34 GET Lat Long 00XXX. HRS 000XX. MIN 0XX.XX SEC	X X X X X X	Initial display will contain zeros (present time). If not changed by astronaut, calculations will be based on present time.
		Accept PRO Reject Key V25E Load desired GET Lat Long	X X X X X X	

LES ABORT MODE IB

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		d. FL V06 N43 Lat (+N) XXX.XX DEG Long (+E) XXX.XX DEG Alt XXXX.X NM		Altitude above launch pad radius. At this point, altitude/10, VI, and gamma available by keying N73E.
	12	When prplnt dump burn completed		Both CM RCS LOGIC and CM PRPLNT DUMP switches must be on to power CM PRPLNT PURG switch.
CDR		CM PRPLNT PURG - on (up) (purge is audible)	CM RCS He DUMP pb - push	Guarded. CM RCS He DUMP pb should be used to initiate purge following normal dump operation if CM PRPLNT PURG switch fails to initiate purge. Visual fire from RCS engine nozzle extension surfaces after burn to depletion and during purge, is expected and normal.
CDR,CMP			If RHC (both) used for prplnt dump burn RHC (both) - Fire all jets (except plus pitch)	One RHC positioned to command plus yaw and roll (excluding plus pitch) and other RHC positioned to command minus yaw, pitch and roll.
	13	CAB PRESS RELF vlv (2) - BOOST/ENTR (safety latch off)	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - open (CCW)	
LMP	14	cb FLT/PL BAT BUS A, B & BAT C (3) - close		Connects battery bus A, B, and battery C to flight and postlanding bus.

STA/T	STEP	PROCEDURE		PANEL	REMARKS
LMP	15	cb FLT/PL MNA - open	X X		
	16	cb FLT/PL MNB - open	X X		
	17	cb RAD HTRS OVLD (2) - open	X X X		
CDR	18	cb SPS PITCH (2) - open	X X		
	19	cb SPS YAW (2) - open	X X		
3K'	20	rh CAB PRESS RELF vlv - DUMP (safety latch off)	X X X X		Ensures minimum cabin-to-ambient negative ΔP for landing impact.
	21	FLOOD FIXED - POST LDG	X X X X		Provides power from flight and postlanding bus to one floodlight in LH couch area and one floodlight in center couch area.
	22	FLOOD DIM - 1 or 2	X X X X X		Position 1 provides power to two secondary floodlights and position 2 provides power to two primary floodlights when FLOOD FIXED switch in POST LDG position after dc main buses deactivated.
800' CMP	23	CAB PRESS RELF vlv (2) - CLOSE (safety latch off)	X X X X X X	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - close (CW)	Valves must be closed prior to touchdown to prevent water from entering CM.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	24	ELS LOGIC - on (up) (verify)	X X X	Guarded.
CMP	25	CM RCS PRPLNT (both) - OFF	X X	
		CM RCS PRPLNT tb (both) - bp	X X X	Barber pole indicates at least one valve closed in each system.
CDR	26	DIRECT O2 vlv - OPEN (CCW)	X X X	
LMP	27	MN BUS TIE (2) - OFF	X X	Removes battery power from dc main buses.
		CAUTION	X X	
		MN BUS TIE sw must be left in OFF position to ensure that bats A, B, & C are used to pwr postlanding sys only, & to prevent bat shorting caused by water entering CM feed-thru conn	X X X X X X X X X X	
	28	cb BAT RLY BUS (2) - open	X X X	
	29	Postlanding check, 4.17	X	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		5.1.1.3 Mode 1C LES Abort (01:56 - 03:18)		
CDR	1	Abort initiation auto or man THC - CCW		If manual backup required for any auto event after abort initiation it must be performed after LE motor burnout (abort T +00:05) because of the high G environment during LE motor burn.
CMP		CM/SM SEP (both) - on (up)		Guarded. On position is momentary. If abort is initiated with CM/SM SEP switches, subsequent events may require manual initiation and must be performed after LE motor burnout.
		BECO (auto)	Request grd cmd BECO	
00:00		Evnt Tmr rset & counting up (auto)		
		CM/SM deadface (auto)		
		SM C/W lts - on		
LMP		MASTER ALARM pb/lt - on		
CDR		CM RCS press (auto)		

LES ABORT MODE IC

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	RCS cont trnfr (auto)		
00:00.1	CM/SM sep (auto)		
	LE mot fire (auto)		
00:01	SCS/RCS enbl (auto)		
00:01.8	CM/SM sep pyro dead-face (auto)		
00:05	If abort init with CM/SM SEP (both) or BU req for any auto evnt		
00:00	EVNT TMR RSET - RSET		RSET position is momentary.
	EVNT TMR START - START		START position is momentary.
CMP	CM RCS PRESS - on (up)		Guarded. On position is momentary.
	RCS TRNFR - CM		CM position is momentary.
CDR	LES MOT FIRE pb - push		Guarded.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	X	RCS CMD - ON		ON position is momentary.
CDR 00:11		Canard deploy (auto)	CNRD DPLY pb - push	Guarded.
CMP	2	C/W CSM - CM		Extinguishes all SM C/W lights and enables CM RCS lights.
LMP	3	MASTER ALARM pb/lt - push		
CMP	4	Mon LEV stat GMBL LOCK lt - out Abort apogee >30 NM IMU gmbl lock can be avoided during man con FDAIs agree If all above conditions met, go to 5; otherwise go to 18		
	5	TWR JETT (both) - on (up)		Guarded. On position is momentary.
		a. Docking ring sep	CSM/LM FNL SEP (both) - on (up)	Guarded. On position is momentary.

LES ABORT MODE IC

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	b.	TWR attach nuts detonate	X X X	
	c.	TWR jett mot fire	X X	
CDR	6	Damp rates	X X	
	7	Mnvr to entry att R 0°, P 135°, Y 0°	X X X	
	8	BMAG MODE (3) - ATT 1/ RATE 2	X X X	
	9	ATT DBD - MAX	X X	
	10	Set up for CM RCS sys 1 AUTO RCS CM 1 (6) - MNA/MNB	X X X X	
		AUTO RCS CM 2 (6) - OFF	X X X	
	11	BMAG MODE (3) - RATE 2	X X	Prevents FDAI roll bug jump.
	12	EMS FUNC - ENTRY	X X	
	13	EMS MODE - NORM	X X	
	14	When .05 G lt - on .05 G sw - on	X X	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	15	EMS ROLL - on (up)		
	16	Maintain full lift		
50K'	17	Proceed to Earth Ldg Phase, 4.16		
		(LET descent from step 4)		
	18	Establish & maintain min 5 to 10°/sec + pitch rate with RHC		Pitchup rate of at least 5°/second should be maintained until canard and LET begin trailing CM upon descending below entry interface. SCS ATT mode is rate command in all three axes at this time and RHC maximum command is 7°/second.
CMP 24K'		LES TWR jett (auto)		
		a. Docking ring sep	CSM/LM FNL SEP (both) - on (up)	Guarded. On position is momentary.
		b. TWR attach nuts detonate	TWR JETT (both) - on (up)	Guarded. On position is momentary.
		c. SCS RCS disable	RCS CMD - OFF	OFF position is momentary.
		d. TWR jett mot fire		
CDR		Apex cover jett (auto)	APEX COVER JETT pb - push	Guarded.
		Drogue chutes deploy (auto)	DROG DPLY pb - push (2 sec after apex cover jett)	Guarded.

STA/T	STEP	PROCEDURE		PANEL	REMARKS
23.5K'			X		
CDR	19	Mon CAB PRESS ind - starts incr	X	If not incr by 17K' rh CAB PRESS RELF vlv - DUMP (safety latch off)	No increase indicates cabin pressure relief valve failure.
CMP			X	If still no incr CAB PRESS DUMP vlv - open (CCW)	
10K'		Mn chutes & VHF recovery ant deploy (auto)	X		Auto deployment occurs between 10,950 feet and 9,100 feet. Parachutes disreef in ≈15 seconds.
CDR	20	MN DPLY pb - push (within 1 sec) CAUTION CM PRPLNT DUMP should be init immediately after mn chute dis-reefing. If mn or pyro bus lost, use RHCs for burn, not CM PRPLNT DUMP sw.	X		MN DPLY pushbutton should be pushed within one second after pilot chute mortars fire to ensure simultaneous deployment of main parachutes.
CMP	21	CAB PRESS RELF vlv (2) - CLOSE (safety latch off)	X	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - close (CW)	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	22	CM PRPLNT DUMP - on (up) (dump burn is audible)		Guarded.
CMP	23	RCS IND sel - CM 1 CM RCS He PRESS ind - decr	RCS IND sel - CM 2 CM RCS He PRESS ind - decr If not decr or RCS jets not firing	
CDR,CMP			RHC (both) - Fire all RCS jets (except plus pitch) until prplnt are depleted	One RHC positioned to command plus yaw and roll (excluding plus pitch) and other RHC positioned to command minus yaw, pitch, and roll.
LMP	24	Set up entry comm VHF ANT - RECY VHF AM A - SIMPLEX VHF BCN - ON		If VHF AM B SIMPLEX or VHF AM A DUPLEX required, turn off beacon during period of communication.
CDR		XMIT voice (VHF AM) reporting Pos Mn chute disreefed Splash err Crew stat		Continue voice transmission until touchdown.
CMP	25	Crew couch struts (4) - unlock		

LES ABORT MODE IC

STA/T	STEP	PROCEDURE		PANEL	REMARKS
	26	Grd track	X		
		determination	X		
			X		
CMP	a.	Key V37E 21E	X		
			X		
	b.	FL V04 N06	X		
		Option code 00002	X		
		CMC assumed option	X		
		0000X	X		Initially set to 00001 (this vehicle).
		Verify	X		
		R2 = 00001	X		
		PRO	X		
			X		
	c.	FL V06 N34	X		Initial display will contain zeros (present time). If not changed by astronaut, calculations will be based on present time.
		GET Lat Long	X		
		00XXX. HRS	X		
		000XX. MIN	X		
		0XX.XX SEC	X		
			X		
		Accept PRO	X		
		Reject Key V25E	X		
		Load	X		
		desired	X		
		GET Lat	X		
		Long	X		
			X		
	d.	FL V06 N43	X		
		Lat (+N)	X		
		XXX.XX DEG	X		
		Long (+E)	X		
		XXX.XX DEG	X		
		Alt XXXX.X NM	X		Altitude is above launch pad radius. At this point, altitude/10, VI, and gamma is available by keying N73E.
			X		
			X		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	27	When prplnt dump burn complete		
CDR		CM PRPLNT PURG - on (up) (purge is audible)		Both CM RCS LOGIC and CM PRPLNT DUMP switches must be on to power CM PRPLNT PURG switch.
			CM RCS He DUMP pb - push	Guarded pushbutton. CM RCS He DUMP pushbutton should be used to initiate purge following normal dump operation if CM PRPLNT PURG switch fails to initiate purge. Visual fire from RCS engine nozzle extension surfaces, after burn to depletion and during purge, expected and normal.
CDR,CMP			If RHC (both) used for prplnt dump burn RHC (both) - Fire all jets (except plus pitch)	One RHC positioned to command plus yaw and roll (excluding plus pitch) and other RHC positioned to command minus yaw, pitch, and roll.
	28	CAB PRESS RELF vlv (2) - BOOST/ENTR (safety latch off)	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - open (CCW)	
LMP	29	cb FLT/PL BAT BUS A, B & BAT C (3) - close		Connects battery bus A, B, and battery C to flight and postlanding bus.
	30	cb FLT/PL MNA - open		
	31	cb FLT/PL MNB - open		
	32	cb RAD HTRS OVLD (2) - open		

LES ABORT MODE IC

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR	33	cb SPS PITCH (2) - open	X X		
	34	cb SPS YAW (2) - open	X X		
3K'	35	rh CAB PRESS RELF vlv - DUMP (safety latch off)	X X X X		Ensures minimum cabin-to-ambient negative ΔP for CM impact.
	36	FLOOD FIXED - POST LDG	X X X X		Provides power from flight and postlanding bus to one floodlight in LH couch area and one floodlight in center couch area.
	37	FLOOD DIM - 1 or 2	X X X X X		Position 1 provides power to two secondary floodlights, and position 2 provides power to two primary floodlights when FLOOD FIXED switch in POST LDG position and dc main buses deactivated.
800' CMP	38	CAB PRESS RELF vlv (2) - CLOSE (safety latch off)	X X X X X X X	If CAB PRESS DUMP vlv used to equalize ΔP, CAB PRESS DUMP vlv - close (CW)	Valves must be closed prior to touchdown to prevent water from entering CM.
CDR	39	ELS LOGIC - on (up) (verify)	X X X		Guarded.
CMP	40	CM RCS PRPLNT (both) - OFF CM RCS PRPLNT tb (both) - bp	X X X X		OFF position is momentary. Barber pole indicates at least one valve closed in each system.

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR	41	DIRECT O2 vlv - OPEN	X		
		(CCW)	X		
			X		
LMP	42	MN BUS TIE (2) - OFF	X		Removes battery power from dc main buses.
			X		
		<u>CAUTION</u>	X		
			X		
		MN BUS TIE sw must be	X		
		left in OFF position	X		
		to ensure that bats	X		
		A, B, & C are used to	X		
		pwr postlanding sys	X		
		only, & to prevent bat	X		
		shorting caused by	X		
		water entering CM	X		
		feed-thru conn.	X		
			X		
	43	cb BAT RLY BUS (2) -	X		
		open	X		
			X		
	44	Postlanding check, 4.17	X		

LES ABORT MODE IC

5.1.2 RCS/SPS ABORT MODES II, III, IV

Mode II, III, and IV aborts are manually initiated and utilize the SM RCS to provide a safe separation distance from the SIVB. After separation and CSM stabilization, the abort possibilities separate into three categories.

- CM/SM separation and coast-to-landing site (MODE II).
- Shaped trajectory abort utilizing an SPS variable maneuver to correct the trajectory for the desired landing site in the Atlantic Recovery Area (MODE III).
- Abort-to-earth-orbit utilizing the SPS to attain earth orbital altitude and speed (MODE IV).

STA/T	STEP	PROCEDURE		PANEL	REMARKS
		5.1.2.1 Mode II RCS Abort (03:18 to 10:08)			
CDR	1	THC - CCW (4.0 sec min)	X		Direct ullage commanded when THC placed CCW. THC must be left in CCW detent for 4.0 seconds to allow 3.0-second timer (adapter separation) and 0.8-second timer (RCS enable) to operate.
			X		
			X		
			X		
			X		
00:00		Evnt Tmr rset & counting up (auto)	X	EVNT TMR RSET - RSET	RSET position is momentary.
			X	EVNT TMR START - START	START position is momentary.
		BECO (auto)	X	Request grd cmd BECO	
		SII Stage - LV ENG 1, 2, 3, 4 & 5 lts - on	X		
		SIVB Stage - LV ENG 1 lt - on	X		
		Dir ullage started (auto)	X	DIR ULL pb - push	
00:03		Adapter sep (auto)	X	CSM/LV SEP pb - push	Guarded.
		All LV ENG lts - out	X		
			X		
CMP			X		
00:03.8		RCS/SCS enbl (auto)	X	RCS CMD - ON	ON position is momentary.
		Key V82E	X		Calls R30 for meaningful display of N50.
		FL V16 N44	X		
		Ha XXXX.X NM	X		Apogee altitude.
		Hp XXXX.X NM	X		Perigee altitude.
		TFF XXBXX MIN-SEC	X		Time of free fall to 49.4 NM (300,000 feet).
			X		
CDR	2	THC - ARMED, ctr & +X trans	X	DIR ULL pb - push	Automatic direct ullage terminated when THC returned to center.

RCS ABORT MODE II

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	3	Key N50E	X	
			X	
		Splash error	X	
		XXXX.X NM	X	Negative for undershoot, positive for overshoot.
		Hp XXXX.X NM	X	
		TFF XXBXX MIN-	X	If TFF <100 seconds, maneuver to entry attitude must
		SEC	X	be initiated immediately and separation performed at
			X	entry attitude.
CDR			X	
00:24	4	Term +X trans	X	
			X	
	5	If TFF <2 min	X	
		Yaw 45° left (out of	X	
		plane)	X	
		Start R&P mnvr to	X	
		entry att R 0°,	X	
		P 120°	X	
			X	
		If TFF <2 min	X	
		Start mnvr to entry	X	
		att R 0°, P 120°,	X	
		Y 0°	X	
			X	
	6	BMAG MODE (3) -	X	
		ATT 1/RATE 2	X	
			X	
CMP	7	CSM/LM FNL SEP (both) -	X	Guarded. On position is momentary. Jettisons docking
		on (up)	X	ring.
			X	
	8	CM/SM SEP (both) - on	X	Guarded. On position is momentary. CM/SM umbilical
		(up)	X	and tension ties severed.
		CM/SM deadface (auto)	X	
		SM C/W lts - on	X	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP		MASTER ALARM pb/lts - on		
CDR		CM RCS press (auto)	CM RCS PRESS - on (up)	Guarded. On position is momentary.
CMP		RCS cont trnfr (auto)	RCS TRNFR - CM	CM position is momentary.
		CM/SM sep (auto)		
		C/W CSM - CM		Extinguishes all SM C/W lights and enables CM RCS C/W lights.
LMP		MASTER ALARM pb/lt - push		
CDR	9	Start yaw mnvr to entry att Y 0°		
	10	ATT DBD - MAX		
	11	Note TFF		Maneuver-to-entry attitude must be completed prior to TFF = 0 seconds.
01:40				
	12	Mnvr to entry att R 0°, P 126°, Y 0°		BEF, heads down, full lift.
	13	Set up for CM RCS sys 1 AUTO RCS CM 1 (6) - MNA or MNB AUTO RCS CM 2 (6) - OFF		
	14	BMAG MODE (3) - RATE 2		Prevents roll bug jump when .05 G switch set to on.

RCS ABORT MODE II

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR	15	EMS FUNC - ENTRY	X X		
	16	EMS MODE - NORM	X X		
	17	When .05 G lt - on, .05 G sw - on (up)	X X X		
	18	EMS ROLL - on (up)	X X		
	19	Maintain full lift	X X		
	20	Proceed to Earth Ldg Phase, 4.16	X X		

STA/T	STEP	PROCEDURE		PANEL	REMARKS
		5.1.2.2 <u>Mode III SPS Abort (10:08 to Insertion)</u>			
CDR	1	THC - CCW (4.0 sec min)	X		Direct ullage commanded when THC placed CCW. THC must be left in CCW detent for 4.0 seconds to allow 3.0-second timer (adapter separation) and 0.8-second timer (RCS enable) to operate.
			X		
			X		
			X		
			X		
00:00		Evnt Tmr rset & counting up (auto)	X	EVNT TMR RSET - RSET	RSET position is momentary.
			X		
			X	EVNT TMR START - START	START position is momentary.
			X		
		BECO (auto)	X	Request grd cmd SIVB BECO	
			X		
		LV ENG 1 lt - on	X		
		Dir ullage started (auto)	X	DIR ULL pb - push	
			X		
00:03		Adapter sep (auto)	X	CSM/LV SEP pb - push	Guarded.
		LV ENG 1 lt - out	X		
CMP			X		
00:03.8		RCS/SCS enbl (auto)	X	RCS CMD - ON	ON position is momentary.
			X		
		Key V82E	X		Calls R30 for meaningful display of N50.
		FL V16 N44	X		
		Ha XXXX.X NM	X		Apogee altitude.
		Hp XXXX.X NM	X		Perigee altitude.
		TFF XXBXX MIN-SEC	X		Time of free fall to 49.4 NM (300,000 ft).
			X		
CDR	2	LV IND/GPI sw - GPI	X		

SPS ABORT MODE III

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	3	THC - ARMED, ctr & +X trans	X DIR ULL pb - push	Automatic direct ullage terminated when THC returned to center.
CMP	4	Key N50E Splash err XXXX.X NM Hp XXXX.X NM TFF XXBXX MIN-SEC		Negative for undershoot, positive for overshoot. If TFF <100 seconds, maneuver to entry attitude immediately.
CDR 00:24	5	Term +X trans		
	6	Mnvr to retro att R 180°, P 194°, Y 0°		BEF, heads up.
	7	Obtain retro update		
	8	BMAG MODE (3) - ATT 1/ RATE 2		
	9	RATE - LO		
	10	Verify SPS GMBL ind (2) = SPS GMBL tw (2) settings		
	11	EMS MODE - NORM		
01:50	12	Start ullage		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	13	ΔV THRUST A - NORM		Guarded.
02:05	14	SPS THRUST - DIR ON		Lever lock.

		If no SPS IGN
		  ΔV THRUST B - NORM
		If still no SPS IGN
		  THRUST ON pb - push		

	15	RATE - HI		Bypasses noise problem in SCS gyro assemblies because of thrusting vibration levels and provides backup to auto selection high rate in pitch and yaw TVC.
	16	Term ullage - IGN +1 sec		
	17	ΔV ind = desired value or ΔR = 0		
		If TFF >2 min Yaw 45° right (out of plane) before CM/SM sep		
		If TFF <2 min, go to 18		
	18	ΔV THRUST (2) - OFF		Guarded.
	19	EMS MODE - STBY		

SPS ABORT MODE III

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	20	Mnvr to entry att R 0°, P 105°, Y 0°		
CMP	21	CSM/LM FNL SEP (both) - on (up)		Guarded. On position is momentary. Jettisons docking ring.
	22	CM/SM SEP (both) - on (up)		Guarded. On position is momentary. CM/SM umbilical and tension ties severed.
		CM/SM deadface (auto)		
		SM C/W lts - on		
		MASTER ALARM pb/lt - on		
		CM RCS press (auto)	CM RCS PRESS - on (up)	Guarded. On position is momentary.
		RCS cont trnfr (auto)	RCS TRNFR - CM	CM position is momentary.
		CM/SM sep (auto)		
	23	C/W CSM - CM		Extinguishes all SM C/W lights and enables CM RCS C/W lights.
LMP	24	MASTER ALARM pb/lt - push		
CDR	25	ATT DBD - MAX		
	26	Note TFF		Maneuver-to-entry attitude must be completed prior to TFF = 0 seconds.
	27	Complete mnvr to entry att		BEF, heads down, full lift.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR	28	Set up for CM RCS sys 1	X	
		AUTO RCS CM 1	X	
		(6) - MNA OR MNB	X	
		AUTO RCS CM 2	X	
		(6) - OFF	X	
			X	
	29	BMAG MODE (3) - RATE 2	X	Prevents roll bug jump when .05 G switch is set to on.
			X	
	30	EMS FUNC - ENTRY	X	
			X	
	31	EMS MODE - NORM	X	
			X	
	32	Maintain full lift to	X	
		.05 G	X	
			X	
	33	When .05 G lt - on,	X	
		.05 G sw - on (up)	X	
			X	
	34	EMS ROLL - on (up)	X	
			X	
	35	Maintain half lift	X	
			X	
50K'	36	Proceed to Earth	X	
		Ldg Phase, 4.16	X	

SPS ABORT MODE III

STA/T	STEP	PROCEDURE		PANEL	REMARKS
		5.1.2.3 <u>Mode IV SPS Abort (09:00 to Insertion)</u>			
CDR	1	THC - CCW (4.0 sec min)	X		Direct ullage is commanded when THC placed CCW. THC must be left in CCW detent for 4.0 seconds to allow 3.0-second timer (adapter separation) and 0.8-second timer (RCS enable) to operate.
			X		
			X		
			X		
			X		
00:00		Evnt Tmr rset & counting up (auto)	X	EVNT TMR RSET - RSET	RSET position is momentary.
			X		
			X	EVNT TMR START - START	START position is momentary.
			X		
		BECO (auto)	X	Request grd cmd SIVB BECO	
			X		
		LV ENG 1 lt - on	X		
		Dir ullage started (auto)	X	DIR ULL pb - push	
			X		
00:03		Adapter sep (auto)	X	CSM/LV SEP pb - push	Guarded.
			X		
		LV ENG 1 lt - out	X		
CMP			X		
00:03.8		RCS/SCS enbl (auto)	X	RCS CMD - ON	ON position is momentary.
			X		
CDR	2	LV IND/GPI sw - GPI	X		
			X		
	3	THC - ARMED, ctr & +X tran	X	DIR ULL pb - push	Automatic direct ullage terminated when THC returned to center.
			X		
			X		
CMP	4	Key V82E	X		
		FL V16 N44	X		
		Ha XXXX.X NM	X		
		Hp XXXX.X NM	X		
		TFF XXBXX MIN-SEC	X		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR				
00:24	5	Term +X trans		
	6	Mnvr to insertion att R 180°, P 350°, Y 0°		SEF, heads down. Slight movement of GPI indicator (4) will be observed if SCS TVC (2) - RATE CMD.
	7	Obtain insertion update		
	8	BMAG MODE (3) - ATT 1/ RATE 2		
	9	RATE - LO		
	10	Verify SPS GMBL ind (2) = SPS GMBL tw (2) settings		
	11	EMS MODE - NORM		
01:00				
	12	Start ullage		
	13	ΔV THRUST A - NORM		Guarded.
02:05				
	14	SPS THRUST - DIR ON		Lever lock.
		If no SPS IGN ΔV THRUST B - NORM		
		If still no SPS IGN THRUST ON pb - push		

SPS ABORT MODE IV

STA/T	STEP	PROCEDURE		PANEL	REMARKS
CDR	15	RATE - HI	X		Bypasses noise problem in SCS gyro assemblies because of thrusting vibration levels and provides backup to auto selection of high rate in pitch and yaw TVC.
			X		
			X		
			X		
	16	Term ullage - IGN	X		
		+1 sec	X		
			X		
	17	BMAG MODE PITCH - RATE 1	X		
		SPS GMBL tw - maintain	X		
		pitch profile (VI,	X		
		H dot, H)	X		
			X		
	18	ΔV THRUST (2) - OFF on	X		
		VI	X		
			X		
	19	SPS THRUST - NORM	X		Lever lock.
			X		
	20	EMS MODE - STBY	X		
		SECO +40 sec	X		
		Stat from grd	X		
			X		
	21	SAFE ORBIT	X		
CMP		PRO (exit R30)	X		
		Key V37E OOE	X		
			X		
	22	Postorbital Insertion	X		
		Check, 4.3.2	X		

5.2 MALFUNCTION PROCEDURES

INTRODUCTION

Malfunction procedures encompass the recognition, diagnosis, and corrective action for system malfunctions. In most cases, the crew is alerted to a malfunction condition by C&WS lights and indicators, or by the absence of a scheduled function or event. The crew will then locate, correct, or isolate the malfunction and determine its effect on the scheduled mission. In general, the procedures cover significant single failures. Double unrelated failures are not covered to prevent procedures from becoming complex and unmanageable.

The malfunction procedures are presented in logic flow diagram format and arranged by symptom routines. The symptom routines contain the primary malfunction procedures and are backed up by special subroutines and system reconfiguration routines where necessary. A three column format is used for symptom routine logic flow diagrams. A description and use of each of these columns is as follows:

Symptom Column. The primary purpose of the symptom column is to allow entry into the malfunction procedures. Two types of symptom logic blocks are used in this column. These are the "C/W Status Light" and "Other Symptom" blocks. These two blocks, along with the supporting information under each block, explain and qualify the situation so the reader fully understands the symptom or condition that exists. All symptoms are arranged by systems, i.e., G&C, SPS, RCS, EPS, etc., and are numbered in sequence starting with number 1 for each system. A subsymptom that is directly related to a major symptom is identified by using the same number followed by a lower case letter, 1a, 1b, 1c, etc.

Procedure Column. The procedure column presents a step-by-step logic flow diagram of actions and decisions used to isolate or correct a malfunction symptom. This information is presented with several types of logic blocks. These blocks contain the procedures, decisions, and actions to locate and isolate the failure. Caution and Warning blocks alert the crew to situations which, if not corrected, may degrade the operational integrity of the SC systems or may have critical crew safety consequences. Remote event symbols are used to reference items in the Remarks column or to refer to other procedural steps.

Remarks Column. This column will include the following information:

a. Amplifying additional remarks related to the symptom, i.e., relief valve vents at ____ psia, burst disc ruptures at ____ psia, or to notify the user of the urgency that he must treat a particular symptom, etc.

b. Amplifying remarks which relate to a decision and/or action items (e.g., why a step is taken, possible system time lag, etc.).

c. Explain resultant system status or operational capability after a failure has been identified, i.e., how subsystem is degraded, can degraded subsystem support primary mission, early termination of mission, etc.

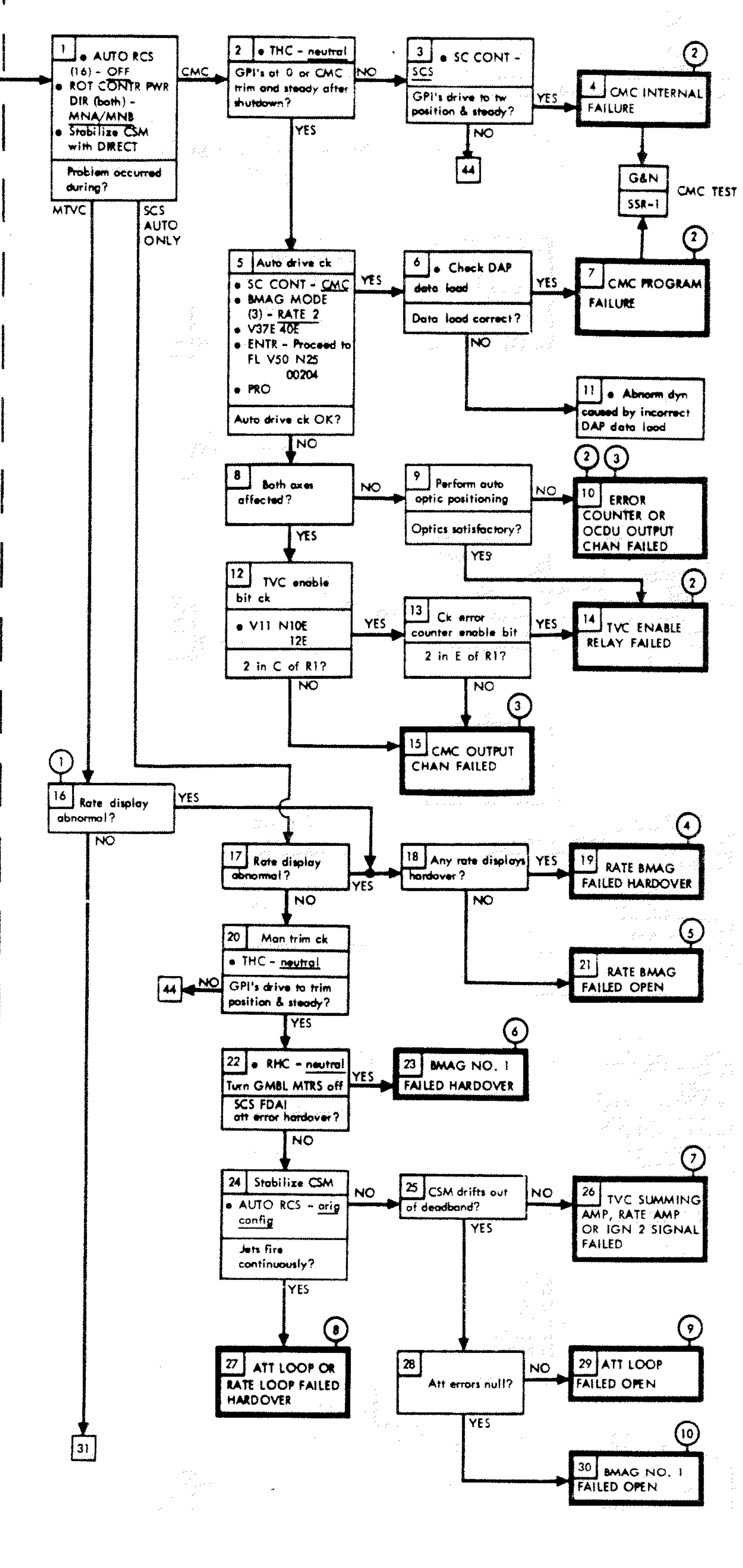
d. Cautions or Warnings, as necessary, to cover conditions that may exist because of a failure.

Symptom	Number	Page
5.2.2 SERVICE PROPULSION SYSTEM		
SPS PRESS lt - on	1	5-83
Fuel and/or Oxid Press High	1a	5-83
Fuel and/or Oxid Press Low	1b	5-83
Fuel and Oxid ΔP >20 psi	1c	5-83
Pitch (Yaw) Gmbl 1 (2) lt - on	2	5-84
SPS Premature Shutdown	3	5-84
No SPS Ignition	3a	5-84
SPS Eng Does Not Shut Down Auto	4	5-85
SPS Thrust lt on - Non Thrusting	4a	5-85
SPS Pc Abnormal	5	5-85
SPS He Vlv tb - Abnormal	6	5-85
He Press Low or Decr	7	5-86
GN2 A (B) Press Low	8	5-86
SPS Inj Vlv Partially Open	8a	5-86
SPS Inj Vlv Ind Abnormal	9	5-86
No Prplnt Temp Control	10	5-86
No Response of SPS Oxid Vlv tb During Flow Adjust	11	5-87
SPS Oxid Unbal Ind Erratic or Pegged	12	5-87
SPS Oxid (Fuel) Qty Ind Readout Abnormal	13	5-87
5.2.3 REACTION CONTROL SYSTEM		
5.2.3.1 SM RCS		
SM RCS A (B,C,D) lt - on	1	5-89
SM RCS Pkg Temp Low	1a	5-89
SM RCS Pkg Temp High	1b	5-89
SM RCS SEC FUEL Press Low	1c	5-89
SM RCS SEC FUEL Press High	1d	5-89
SM RCS He Press Low or Decr	2	5-90
SM RCS Prplnt Qty Low or Decr	2a	5-90
5.2.3.2 CM RCS		
CM RCS 1 (2) lt - on	3	5-90
CM RCS Manf Press High	3a	5-90
CM RCS Manf Press Low	3b	5-90
CM RCS He Press Low or Decr	4	5-90
CM RCS Eng Temp Fails to Incr	5	5-90
5.2.4 ELECTRICAL POWER SYSTEM		
5.2.4.1 Cryogenics		
CRYO PRESS lt - on	1	5-91
O2 (H2) Cryo Press Hi	1a	5-91
O2 (H2) Cryo Press Low	1b	5-91

SYMPTOM	PROCEDURE	REMARKS

G&C

1 ABNORMAL VEHICLE DYNAMICS DURING SPS THRUSTING



REMARKS

(1) Thrust is shut off and system returned to configuration at failure. If gmbl motors are off, they must be turned on before starting this procedure.

(2) CMC SPS control capability lost.

(3) Auto optics lost

(4) SCS auto ΔV lost. MTVC possible if redundant BMAG placed in RATE position.

(5) An open rate BMAG may be confirmed by null rate displays. SCS ball drive lost in axis unless alternate rate BMAG used. If YAW or ROLL: If BMAG 1, after .05G, SCS roll att erroneous. If BMAG 2, after .05 G, EMS RSI erroneous unless in RATE 1. Rate damping and SCS auto ΔV lost. For MTVC, use alternate rate BMAG.

(6) SCS auto ΔV lost if pitch or yaw. If roll, control attitude with Direct or ACCEL CMD.

(7) SCS auto ΔV capability lost.

(8) SCS RATE CMD, att hold, and proportional control lost for affected axis. SC auto ΔV lost if pitch or yaw. Translations without att hold possible in MIN IMP. Further troubleshooting not recommended.

(9) Att hold capability lost in affected axis. SCS auto ΔV lost if pitch or yaw.

(10) For affected axis: In ATT 1 RATE 2, att hold and att error display lost. After .05 G, SCS FDAI roll att erroneous if yaw or roll.

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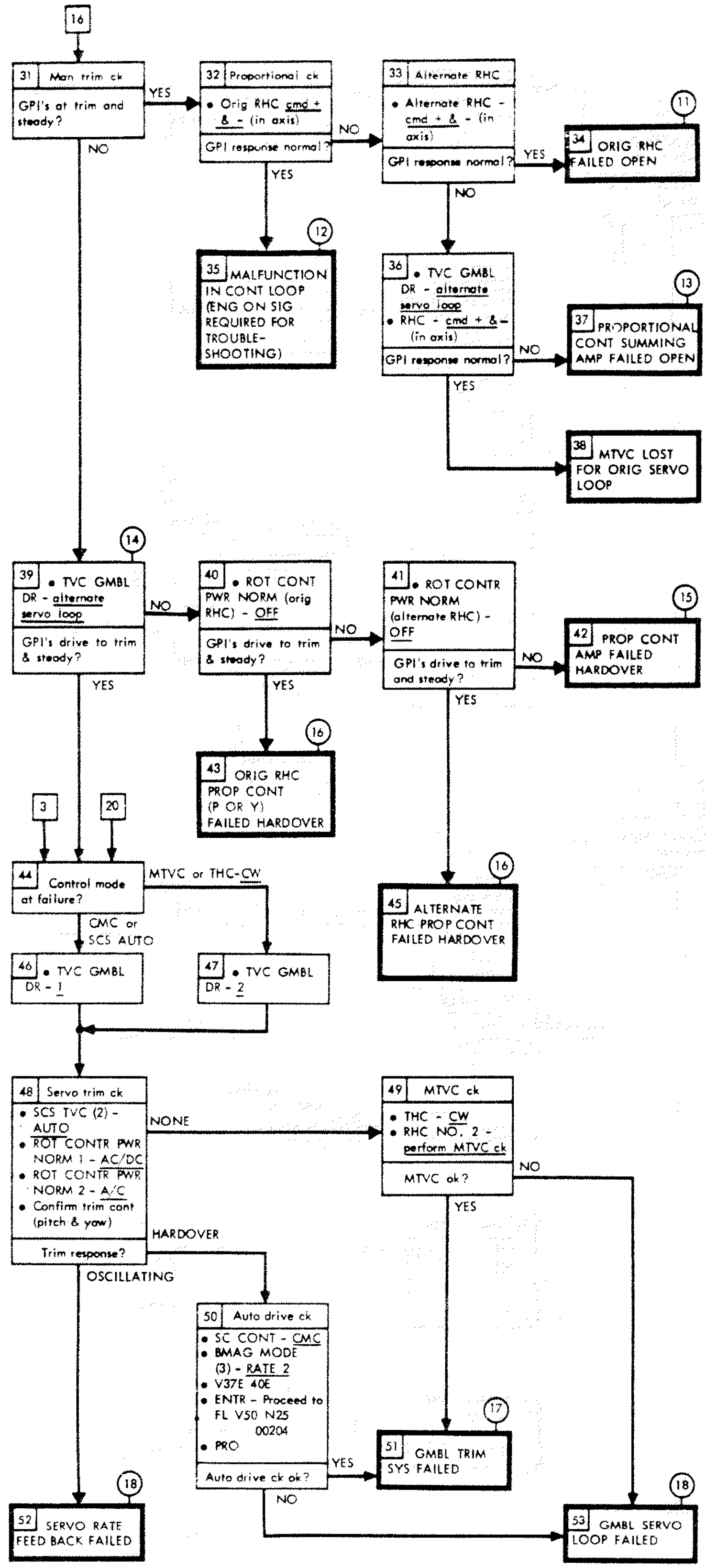
SYMPTOM	PROCEDURE	REMARKS

G&C

1 (Cont)



(11) SCS proportional control and MTVC lost for failed RHC.

(12) One probable failure could be loss of MTVC integrator in which case during MTVC the gimbal position directly follows the stick position.

(13) SCS proportional control and MTVC lost for both RHC's.

(14) If THC - CW at time of failure, servo #2 being used, select servo #1.

(15) No MTVC capability. RATE CMD lost in affected axis. Att hold possible if RHC's locked (or neutral) or ROT CONTR PWR NORM (2) - OFF. Disable affected axis if direct used.

(16) MTVC and proportional cont available with unaffected RHC if affected RHC ROT CONT PWR NORM sw is OFF or RHC locked.

(17) CMC ΔV unaffected. On affected servo, SCS auto ΔV and trim lost, but MTVC without trim remains.

(18) Affected servo lost for all ΔV's.

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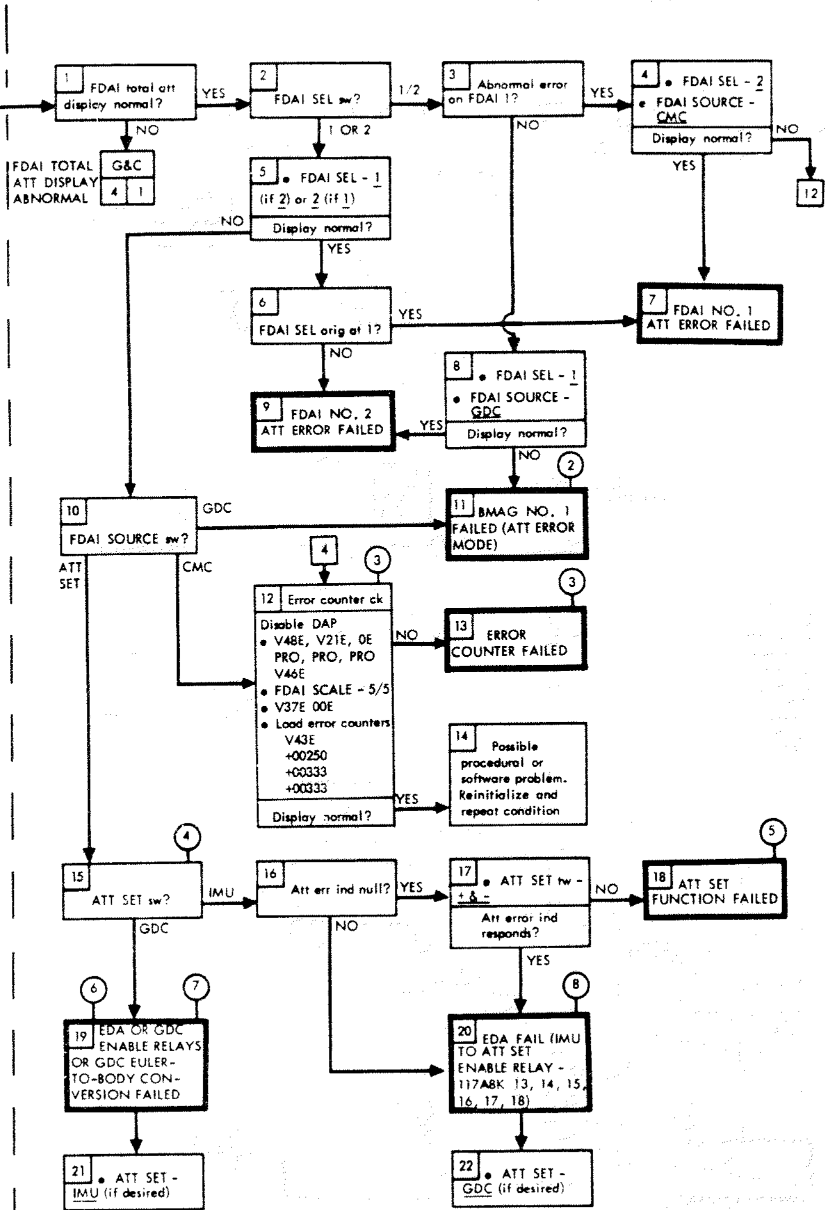
SYMPTOM	PROCEDURE	REMARKS

G&C

2 FDAI ATT ERROR ABNORMAL (1)



(1) May be single or multi axis.

(2) RATE 1 operation from this BMAG may not be available.

(3) CMC attitude error, coarse align and SIVB attitude control lost for axis that showed abnormal in error counter check.

(4) Cycling ATT SET sw may free sticking relays.

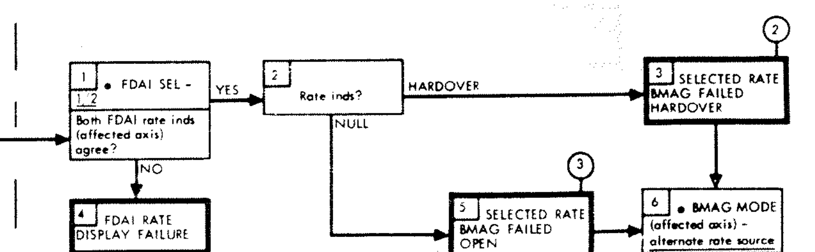
(5) Attitude error functions are inoperative when FDAI SOURCE switch at ATT SET.

(6) Failure of GDC enable relays will be determined by an inability to align GDC by GDC ALIGN pb.

(7) SCS att set error display lost. If ATT SET - IMU, attitude errors displayed will be Euler angles.

(8) IMU function of ATT SET sw lost.

3 FDAI RATE IND ABNORMAL (1)



(1) May be single or multiple axes.

(2) Attitude error display and attitude hold capability lost. SCS auto ΔV lost if pitch or yaw: for roll place MAN ATT ROLL - ACCEL CMD and control roll manually. If failure is No. 1 roll or yaw BMAG after .05 G, No. 2 FDAI roll ind will spin up.

(3) If BMAG No. 2 failed: SCS auto ΔV lost unless in roll, then place BMAG MODE ROLL - ATT 1 RATE 2 and LIM CYCLE - on (up). RCS attitude hold available in all axes with BMAG MODE (3) - ATT 1 RATE 2 and LIM CYCLE on (up). If roll or yaw BMAG No. 1 failed, No. 2 FDAI roll ind erroneous after .05 G.

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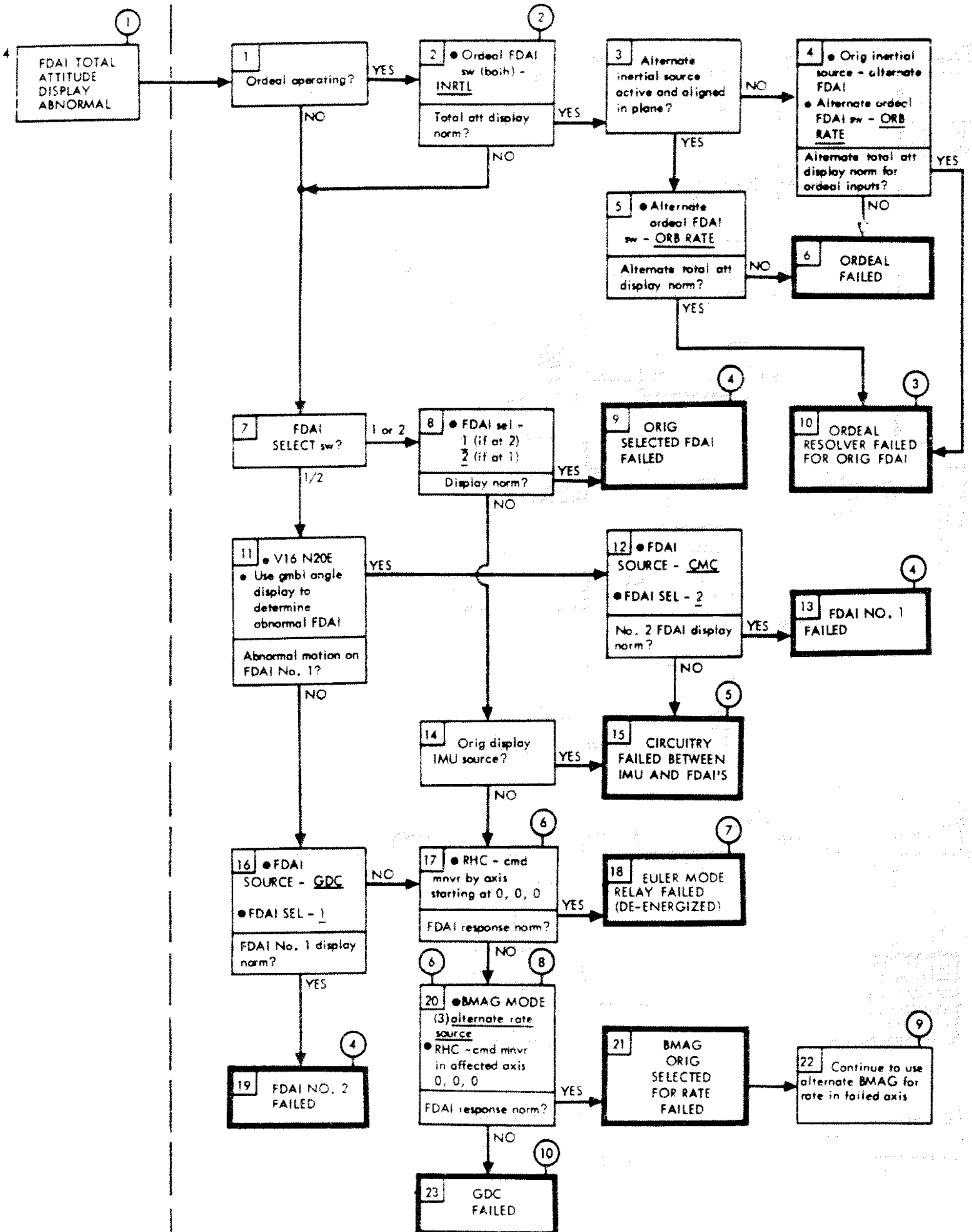
SYMPTOM	PROCEDURE	REMARKS

G&C

4



(1) For GDC FDAI total attitude, if rate display(s) also hardover, enter "FDAI Rate Ind Abnormal" procedure.

(2) Assumes inertial reference for orbital rate FDAI is aligned in plane.

(3) Use alternate FDAI for subsequent orbital rate displays.

(4) Confirm FDAI failure by placing alternate inertial source on affected FDAI. Normal total attitude with alternate inertial source indicative of Golden G relay failure.

(5) Any failure of IMU itself would have been indicated by ISS light.

(6) The FDAI can be aligned to 0, 0, 0 by the GDC align pb.

(7) Attempt only single-axis maneuvers in order pitch, yaw and roll. This failure has no effect after .05 G since Euler mode relays are disabled.

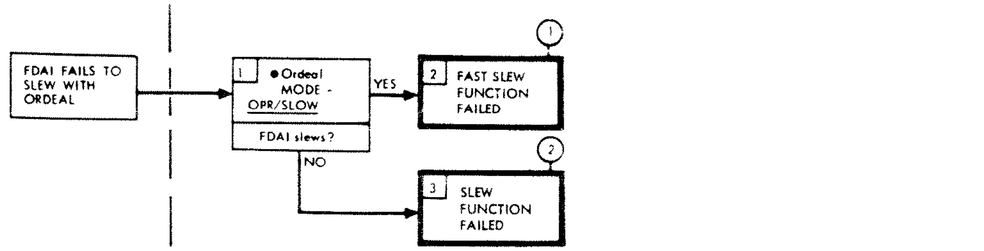
(8) Assumes alternate rate source operable.

(9) After .05 G, if BMAG NO. 1 fails in yaw or roll, FDAI Roll Att will be erroneous; if BMAG No. 2 fails in yaw or roll, EMS RSI attitude will be erroneous unless RATE 1 selected.

(10) Entry capability can be determined from GDC FDAI roll ind and EMS RSI response when a yaw maneuver is commanded with .05 G sw and EMS ROLL sw - on (up).

Total attitude capability lost for affected axis. After .05 G, if failure axis is:
YAW - EMS RSI invalid
ROLL - No. 2 FDAI roll ind invalid.

5



(1) Slew FDAI at slow rate.

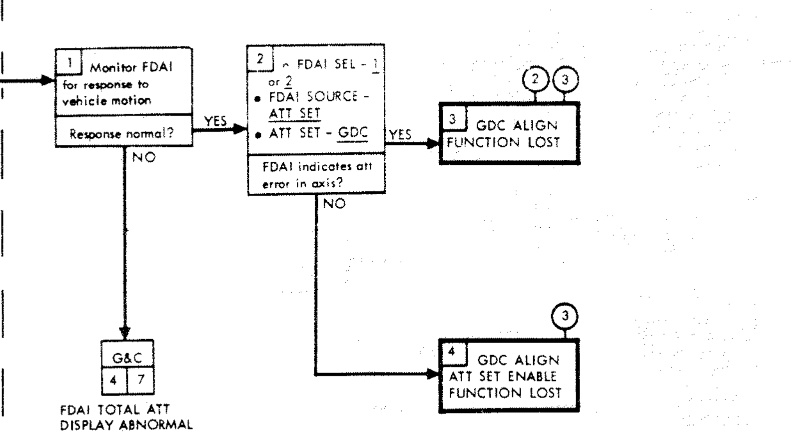
(2) With an in-plane GDC alignment, FDAI pitch angle may be set by pressing GDC align pb and slewing pitch att set tw.

SM-2A-1943D

SYMPTOM	PROCEDURE	REMARKS

G&C

6 FDAI TOTAL ATT DOES NOT RESPOND TO GDC ALIGN (1)



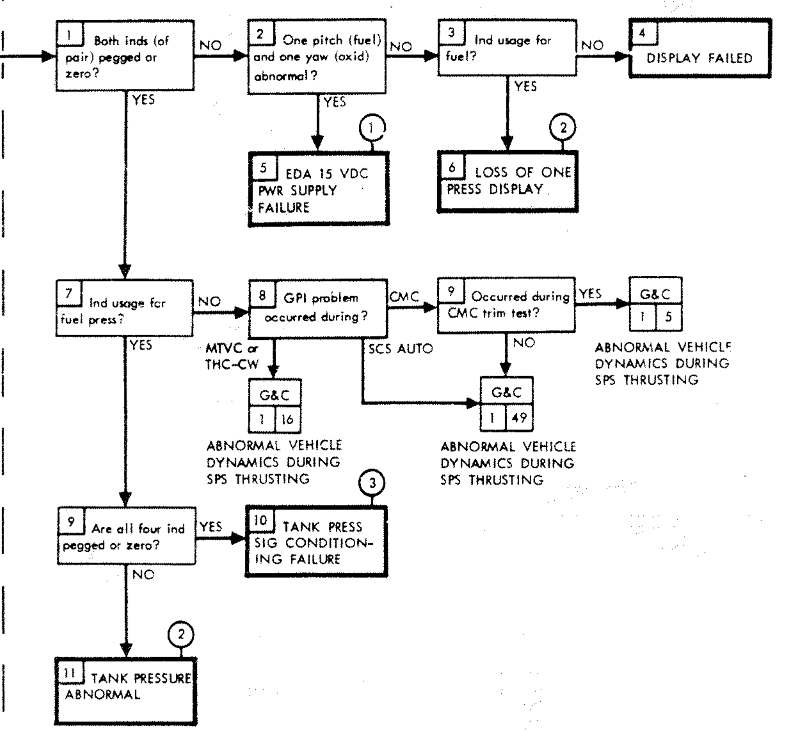
REMARKS:

(1) May be single or multiple axes.

(2) Att set error displays still operational.

(3) GDC can be aligned to an arbitrary position by:
- a. Fly CSM to indicated attitude to which GDC is to be aligned.
- b. Disable GDC.
- c. Fly CSM to prescribed inertial attitude (star or visual reference).
- d. Re-enable GDC.

7 GPI/FUEL PRESS IND(S) PEGGED OR ZERO



REMARKS:

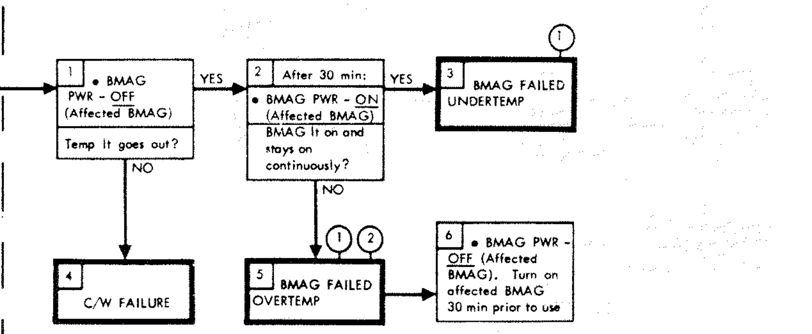
(1) Total attitude, attitude error & rate display lost for 1 FDAI.

(2) Check GPI operation during first gimbal drive and trim check.

(3) Utilize MSFN to monitor tank press.

8 BMAG 1 (2) TEMP

Yellow lt on if temp
<168
>172



REMARKS:

(1) BMAG rate information relatively unaffected by temperature out-of-tolerance. However attitude error information degrades ~4% per degree out of tolerance.

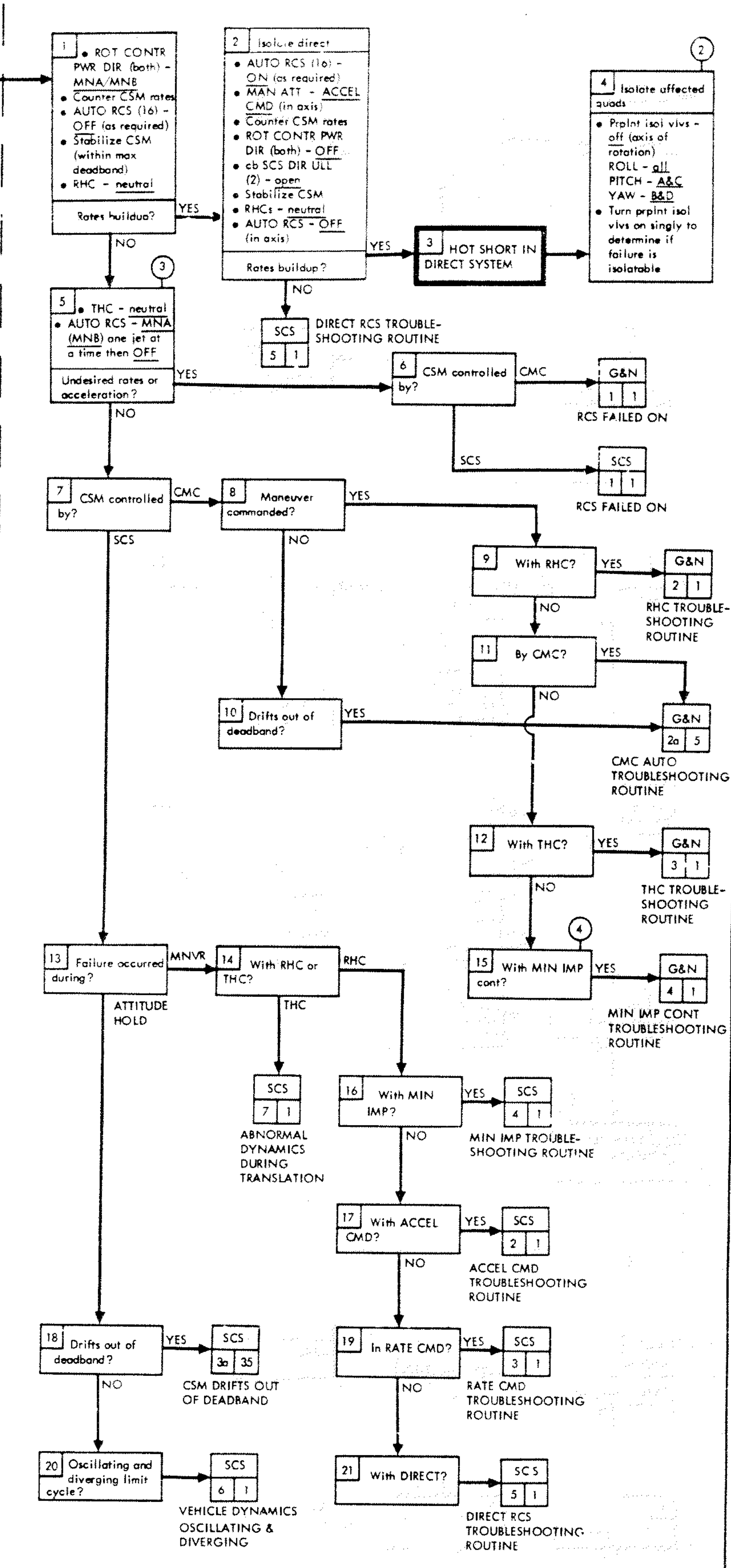
(2) Time that the BMAG TEMP lt is off is an indication of the temperature rate increase and period of accuracy for subsequent BMAG use.

SM-2A-1896H

SYMPTOM	PROCEDURE	REMARKS

SCS (1)

A ABNORMAL VEHICLE DYNAMICS (NON-SPS THRUSTING LM - INACTIVE)



REMARKS

(1) Abnormal dynamics is defined to mean undesired rates or accelerations during uncommanded maneuvers or abnormal response during commanded maneuvers.

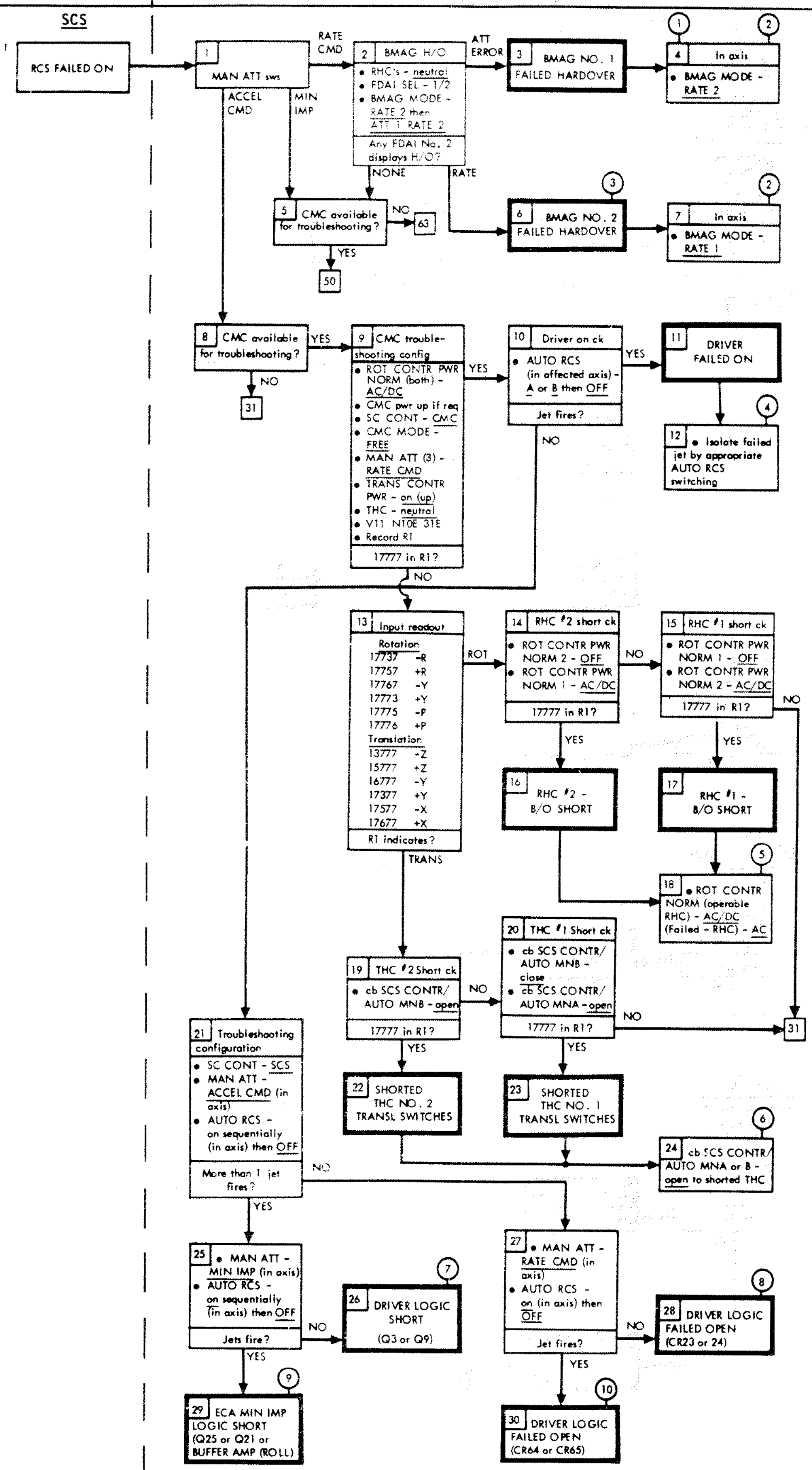
(2) Auto RCS switches for all jets on affected quad should be placed to off position before quad isolation.

(3) CSM should be stabilized within the attitude deadband (if in an attitude hold mode) to preclude normal jet firings resulting from being outside rate or attitude deadbands.

(4) Would occur in FREE mode only.

SM-2A-1940F

SYMPTOM	PROCEDURE	REMARKS

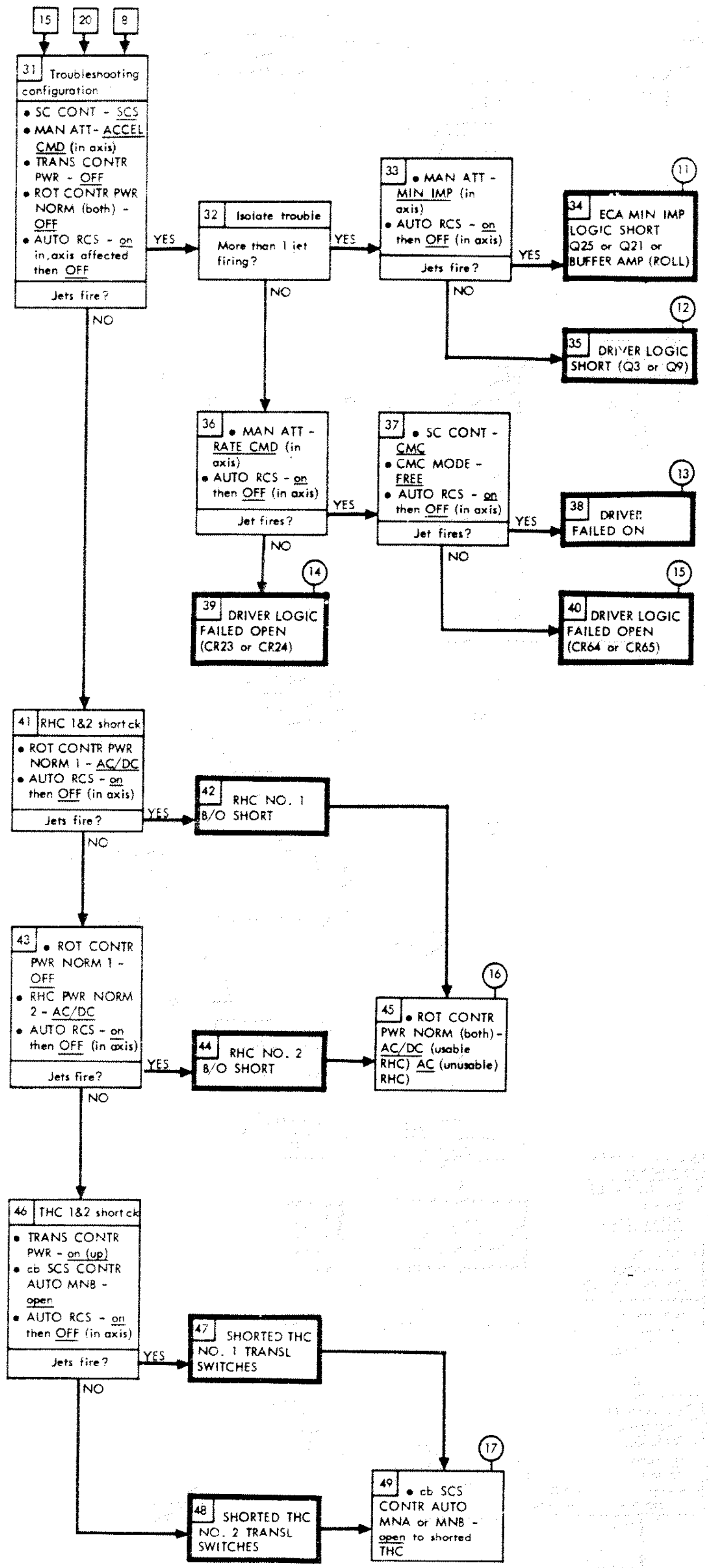


1. If failure is in roll or yaw after 0.05G, GDC driven ball will spin up.
2. Attitude hold lost in affected axis. SCS auto ΔV lost if pitch or yaw. If roll, control attitude by direct or ACCEL CMD.
3. BMAG No. 2 hardover will cause FDAI No. 2 total attitude to drive randomly in Euler modes.
4. Affected thruster lost for all auto coil operation. Direct mode unaffected.
5. Direct sws in affected RHC still functional. Affected RHC lost for SCS and G/N attitude control. If RHC 2, swap RHC 1 to CDRs position and leave RHC 2 off. For ΔV's replace RHC 2 to CDR's position and leave in AC only.
6. Still have translation capability through redundant switches in THC. Select operable enable bus with AUTO RCS.
7. ACCEL CMD lost in pitch or yaw.
8. ACCEL CMD lost for that jet.
9. All SCS RCS (auto coils) lost for affected axis. Disable affected jets with AUTO RCS sws and use direct.
10. SCS auto RCS coil modes lost for affected jet. If affected jet is in roll, loss of either +Y or Z translation. If affected jet is in pitch or yaw loss of 4 jet + or -X trans.

SYMPTOM	PROCEDURE	REMARKS

SCS

1 Cont



(11) All SCS RCS (auto coils) lost for affected axis. Disable affected jets with AUTO RCS sws and use direct control.

(12) ACCEL CMD lost in pitch or yaw. Use alternate quad pair for roll.

(13) This jet lost for all SCS & G/N control modes. Disable jet with AUTO RCS sws and use direct control.

(14) ACCEL CMD lost for this jet.

(15) SCS AUTO RCS coil modes lost for affected jet. If affected jet is in roll loss of either +Y or Z trans. If affected jet is in pitch or yaw, loss of 4 jet + or -X trans.

(16) Direct sws in affected RHC still functional. Affected RHC lost for SCS and G/N attitude control. If RHC 2, swap RHC 1 to CDR's position and leave RHC 2 off. For ΔV's replace RHC 2 to CDR's position and leave in AC only.

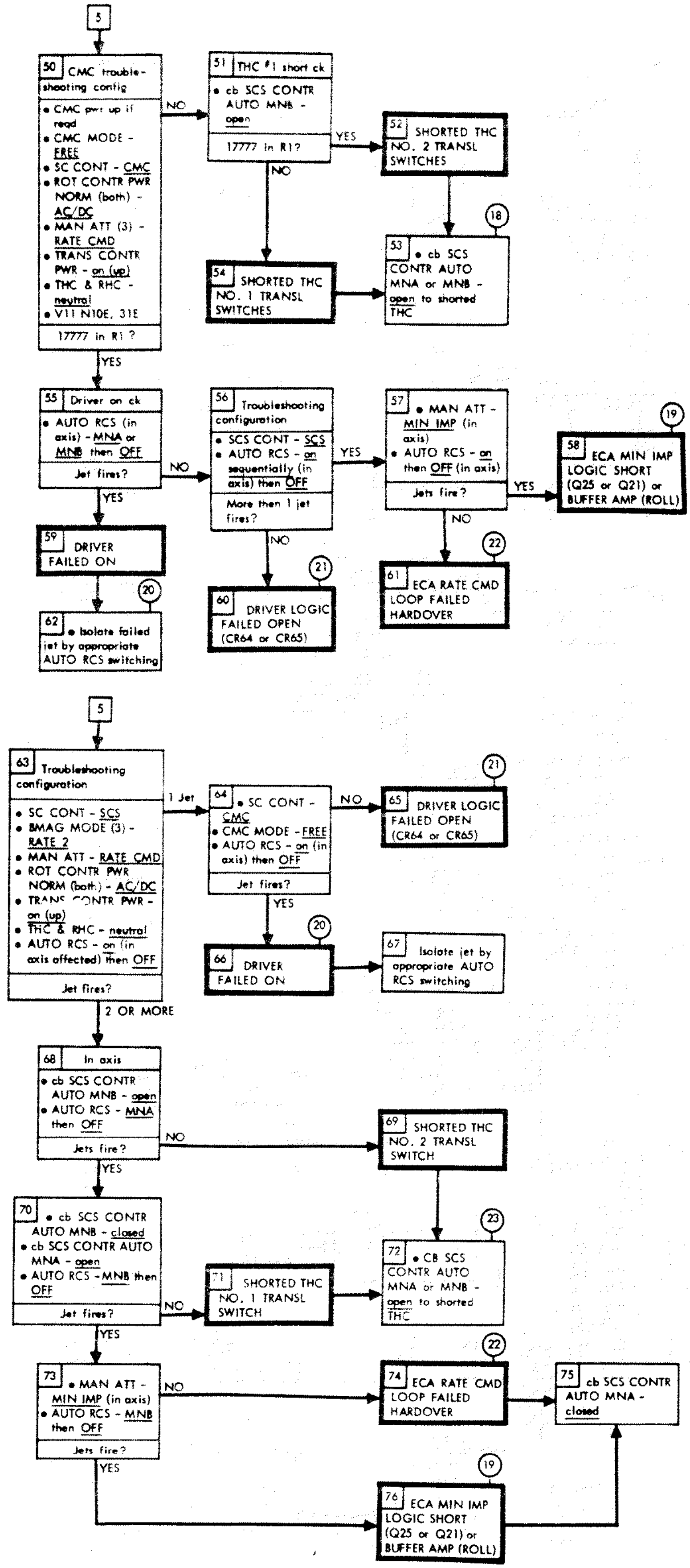
(17) Still have translation capability through redundant sws in THC. Select operable enable bus with AUTO RCS.

SM-2A-1945C

SYMPTOM	PROCEDURE	REMARKS

SCS

1 cont



(18) Still have translation capability through redundant sws in THC. Select operable enable bus with AUTO RCS.

(19) All SCS RCS (auto coils) lost for affected axis. Disable affected jets with AUTO RCS sws and use direct control.

(20) This jet lost for SCS & G&N control modes. Use direct control in affected axis.

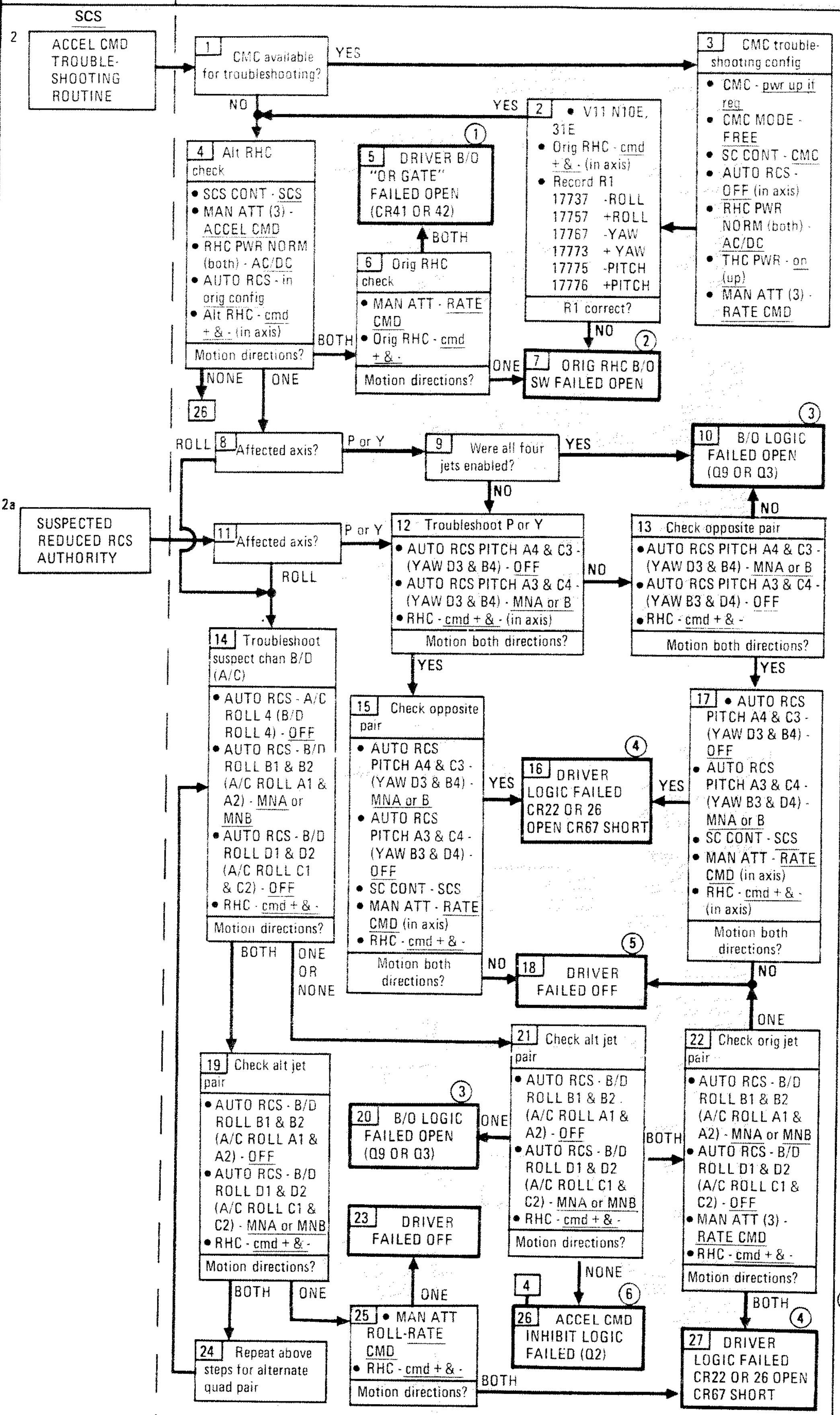
(21) SCS AUTO RCS coil modes lost for affected jet. If affected jet is in roll loss of either ±Y or Z trans. If affected jet is in pitch or yaw loss of 4 jet + or -X trans.

(22) SCS RATE CMD, attitude hold & prop cont lost for affected jet. SCS auto ΔV lost if pitch or yaw but operable in roll in ACCEL CMD. Translation without attitude hold possible in MIN IMP or ACCEL CMD.

(23) Still have translation capability through redundant sws in THC. Select operable enable bus with AUTO RCS.

SM-2A-1946D

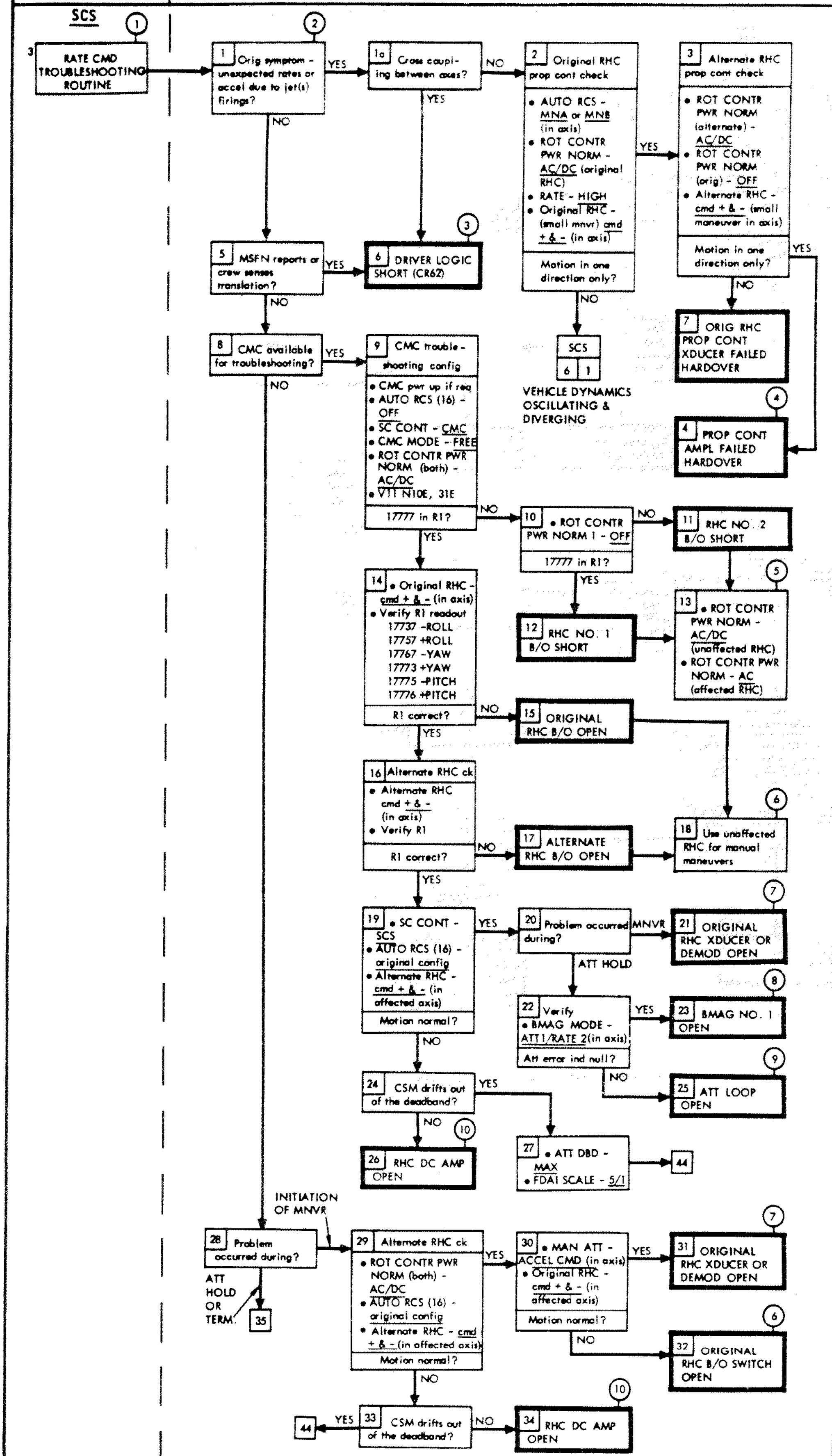
SYMPTOM	PROCEDURE	REMARKS



1. Lose ACCEL CMD capability with one RHC in affected axis. Use alternate RHC.
2. Attitude hold unaffected but proportional control, ACCEL CMD, MIN IMP & CMC manual control lost for failed RHC. Direct unaffected but BMAG caging signal lost. Affected RHC can be used for MTVC.
3. One direction of rotation lost for ACCEL CMD in pitch, yaw, A/C roll or B/D roll.
4. ACCEL CMD mode lost for affected jet. Other SCS & G/N modes available.
5. This jet lost for all SCS & G&N control modes (auto coil). Direct control available.
6. ACCEL CMD lost for affected axis. RATE CMD, MIN IMP, CMC & direct modes available.

SM-2A-1947G

SYMPTOM	PROCEDURE	REMARKS



REMARKS

(1) Assumes full thruster operation except in roll

(2) Assumes RCS thrusters fail on where identified in the "A" flow.

(3) Failure causes translation when rotation cmds given. Attitude hold RATE CMD & MIN IMP lost in one direction for affected axis (pitch, yaw, A/C roll, B/D roll). Translation without attitude hold possible with MAN ATT - MIN IMP

(4) For PROP CONT AMP failed hardover, MTVC and RATE CMD lost in affected axis. Attitude hold possible if RHC's locked (or neutral) or if ROT CONTR PWR NORM (both) - OFF. Disable thrusters in affected axis if direct used.

(5) Direct sws in affected RHC still functional. One RHC lost; however, RATE CMD mode in failed RHC still possible when breakout switches closed in same axis by operable RHC. MTVC ok when ROT CONTR PWR NORM (affected RHC) is at AC

(6) Attitude hold unaffected but prop cont, ACCEL CMD, MIN IMP & CMC man cont lost for failed RHC. Direct unaffected but BMAG caging signal lost. Affected RHC can be used for MTVC.

(7) SCS prop cont & MTVC lost for failed RHC.

(8) For affected axis: In ATT 1 RATE 2, att hold & att error display lost. SCS auto ΔV possible if roll, by controlling attitude manually. After .05 G, SCS FDAI roll attitude erroneous if yaw or roll.

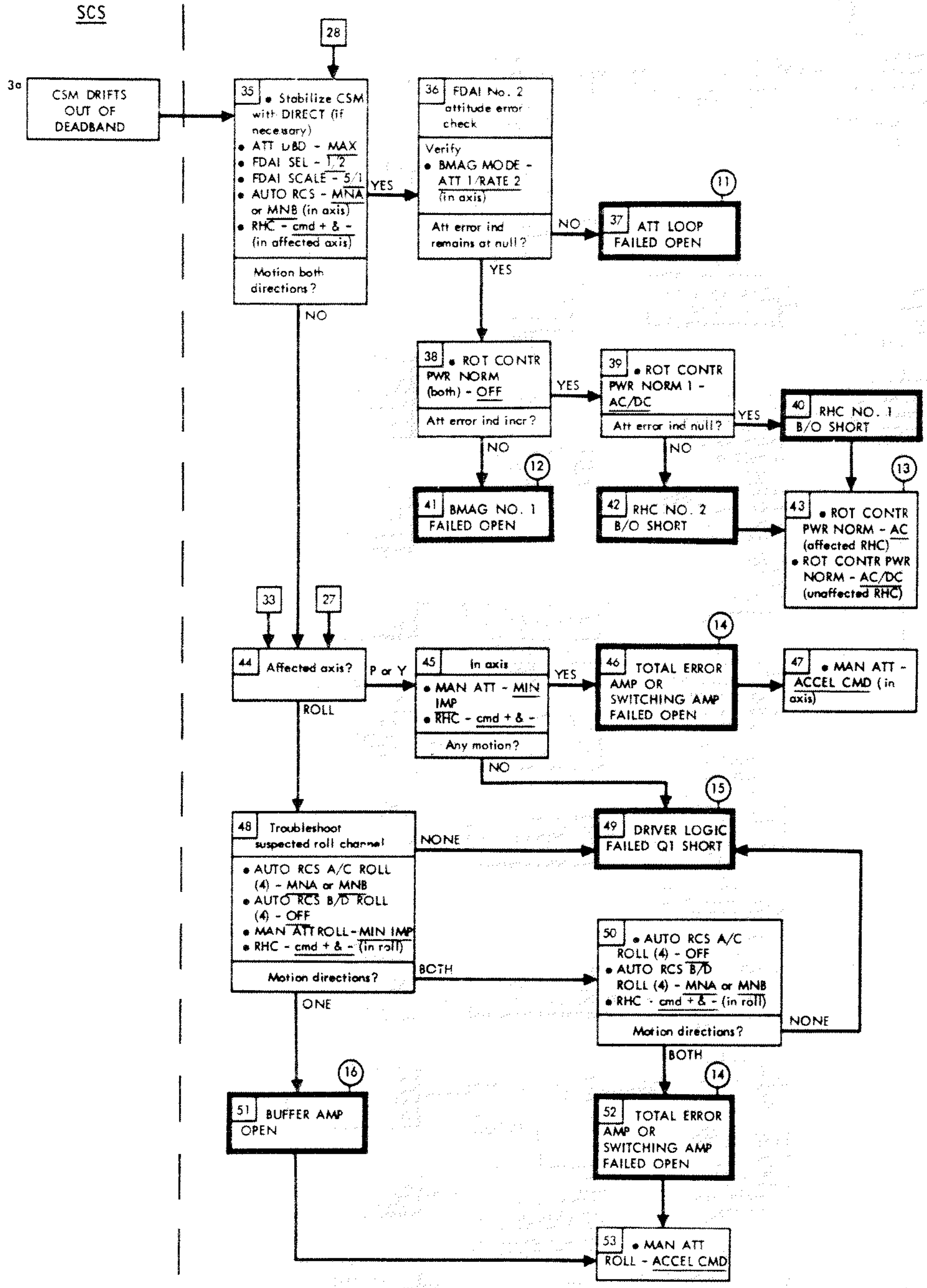
(9) Attitude hold capability lost in affected axis. SCS auto ΔV lost if pitch or yaw, but possible if roll by placing MAN ATT ROLL - ACCEL CMD.

(10) SCS prop cont & MTVC lost for both RHCs.

SM-2A-1950G

SYMPTOM	PROCEDURE	REMARKS

SCS



(11) Attitude hold capability lost in affected axis. SCS auto ΔV lost if pitch or yaw, but possible if roll by placing MAN ATT ROLL - ACCEL CMD.

(12) For affected axis: In ATT 1 RATE 2, att hold & att error display lost. SCS auto ΔV possible if roll, by controlling att manually. After .05 G, SCS FDAI roll attitude erroneous if yaw or roll.

(13) Direct sws in affected RHC still functional. One RHC lost; however, RATE CMD mode in failed RHC still possible when breakout switches closed in same axis by operable RHC. MTVC ok when ROT CONTR PWR NORM (affected RHC) is at AC.

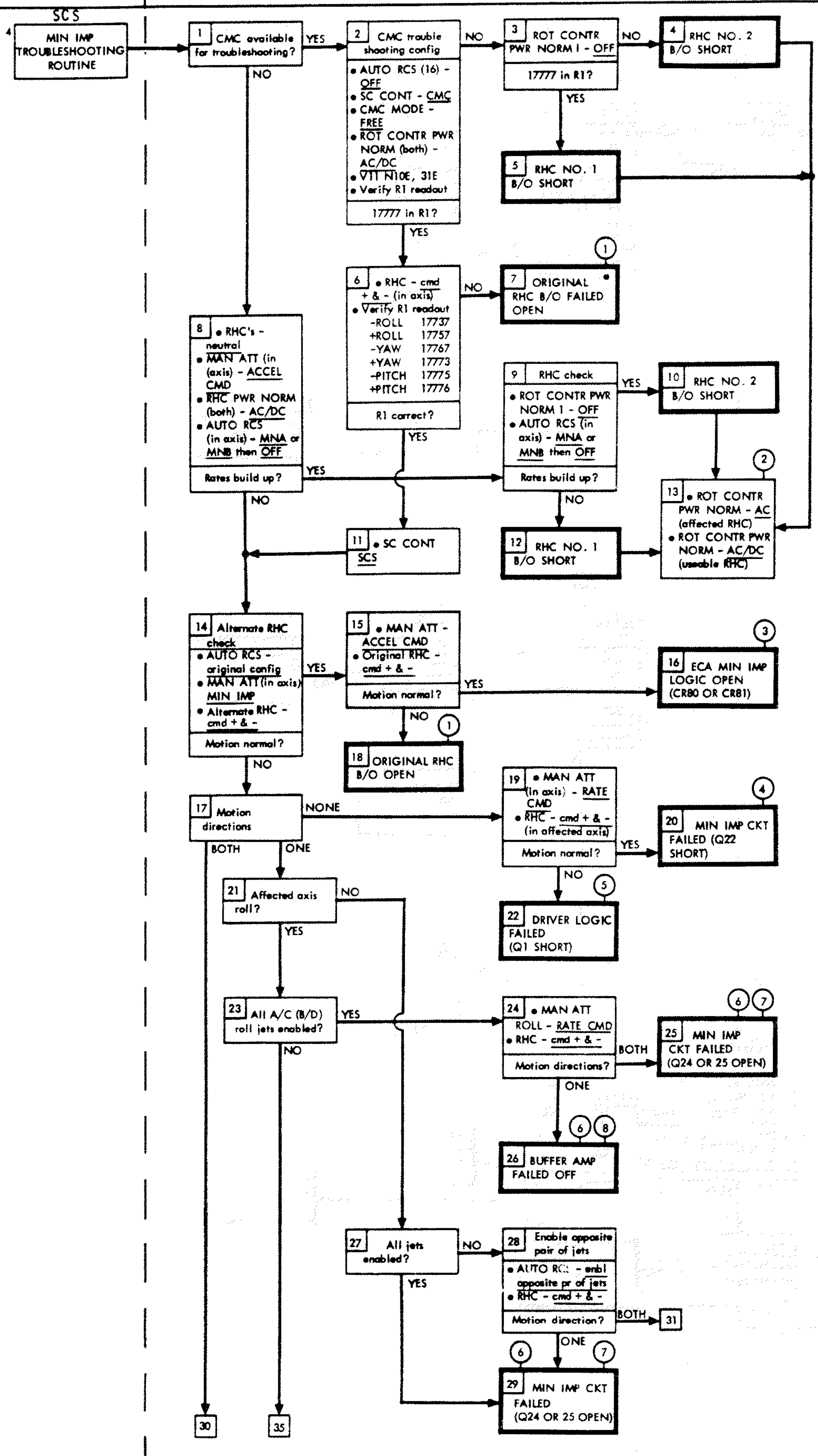
(14) All RATE CMD & attitude hold capability lost for affected axis. Translation possible with MAN ATT sw in RATE CMD & attitude control in affected axis by direct or MIN IMP.

(15) Lose all SCS modes except ACCEL CMD. No Translation on affected axis. Direct control available.

(16) One polarity lost in RATE CMD & MIN IMP. Translation capability remains but attitude hold lost.

SM-2A-1951C

SYMPTOM | PROCEDURE | REMARKS



(1) Lose prop cont ACCEL CMD, MIN IMP & CMC MAN CONT for failed RHC. Direct unaffected but BMAG caging signal lost. Affected RHC can be used for MTVC. Attitude hold unaffected.

(2) Direct sw's in affected RHC still functional. Affected RHC lost for SCS and G/N attitude control. If RHC 2 swap RHC 1 to CDR's position and leave RHC 2 off. For ΔV's replace RHC 2 to CDR's position and leave in AC only.

(3) Loss of MIN IMP cont in one direction of affected axis. RATE CMD & ACCEL CMD still available. BMAG cage function still operational.

(4) Lose MIN IMP in both directions of affected axis. RATE CMD & ACCEL CMD still available.

(5) RATE CMD and MIN IMP lost for affected axis (pitch, yaw, A/C roll or B/D roll). SCS translation capability from affected thrusters lost except by DIR ULL. ACCEL CMD and G/N modes unaffected.

(6) Min engine on time protection lost for RATE CMD & ACCEL CMD.

(7) Lose MIN IMP in one direction of affected axis. RATE CMD & ACCEL CMD available. Translation unaffected.

(8) Lose MIN IMP & RATE CMD in one direction of roll axis. ACCEL CMD available. Roll attitude hold lost. SCS auto ΔV unaffected but control roll attitude manually with ACCEL CMD.

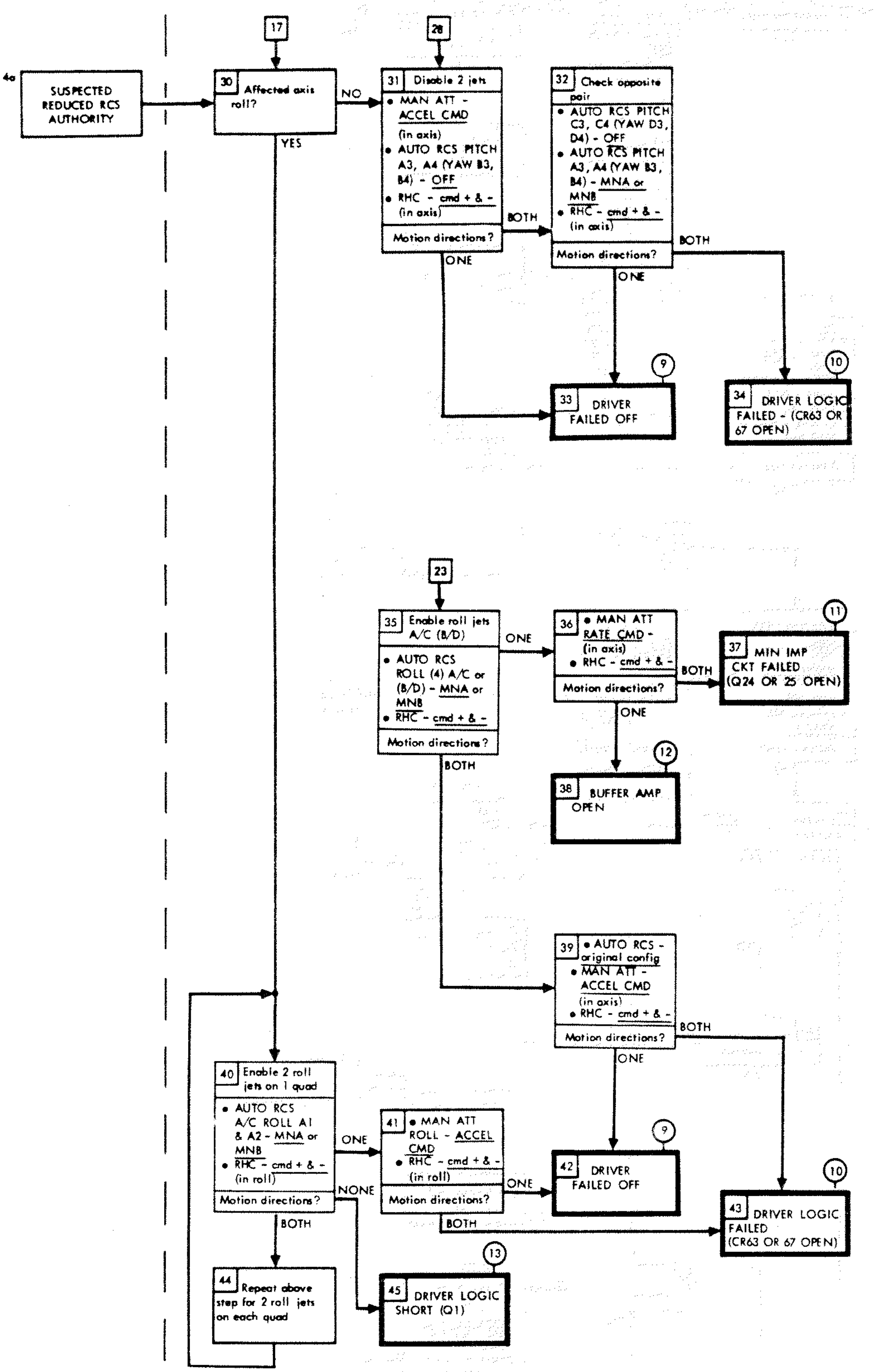
SM-2A-1952D

SYMPTOM	PROCEDURE	REMARKS

SCS

4 (cont)

4a



Remarks

(9) This jet lost for all SCS & G/N control modes. Direct mode of operation available.

(10) Lose RATE CMD & MIN IMP modes. ACCEL CMD still available.

(11) Lose MIN IMP in one direction of affected axis. RATE CMD & ACCEL CMD available. Translation uneffected.

(12) Lose MIN IMP & RATE CMD in one direction of roll axis. ACCEL CMD available.

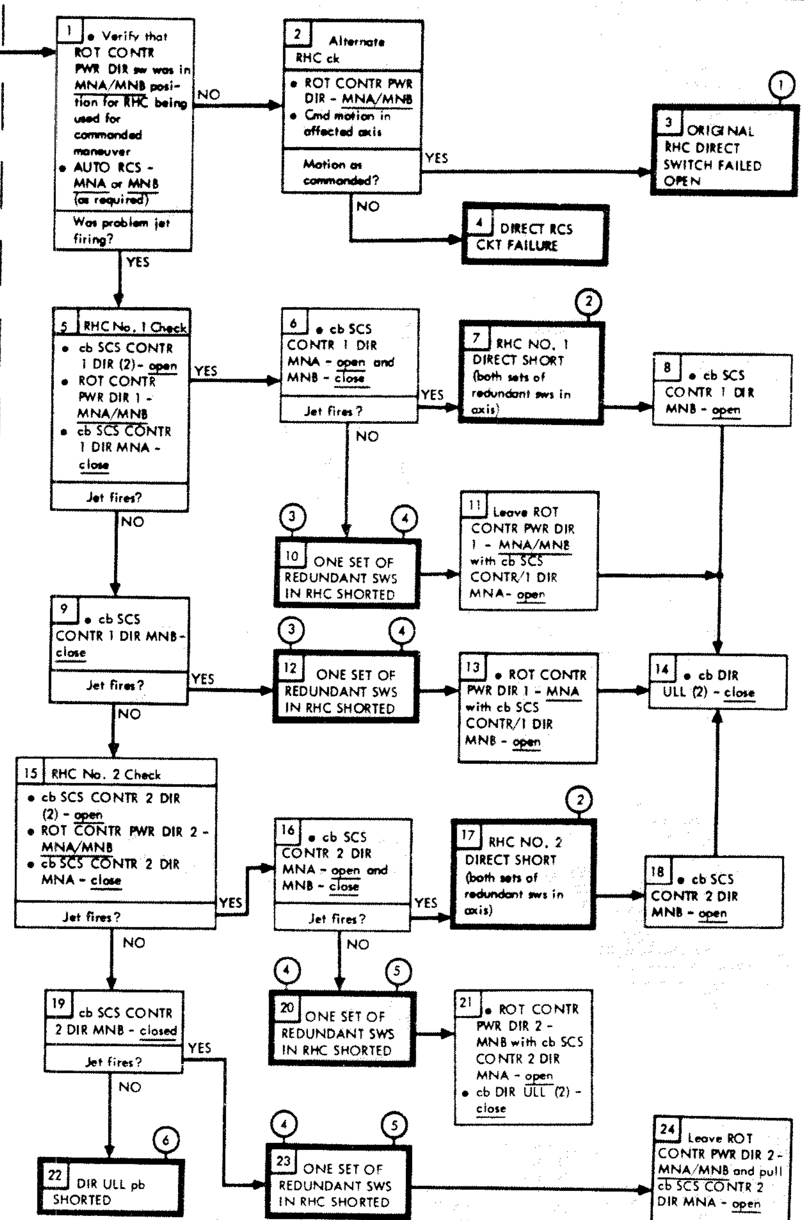
(13) RATE CMD and MIN IMP lost for affected axis (pitch, yaw, A/C roll or B/D roll). SCS translation capability from affected thrusters lost except by DIR ULL. ACCEL CMD and G&N modes unaffected.

SM-2A-1953D

SYMPTOM	PROCEDURE	REMARKS

SCS

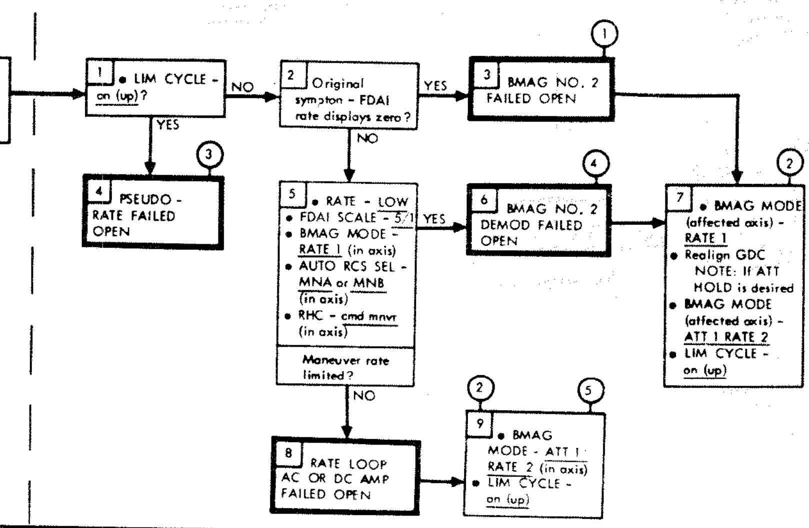
5 DIRECT RCS TROUBLESHOOTING ROUTINE



REMARKS

1. Direct operation with original RHC results in reduced authority in affected axis through redundant switch
2. Direct operation with affected RHC lost.
3. Direct operation with RHC No. 1 functional through redundant set of sws.
4. Loss of one set of redundant direct sws results in reduced authority in affected axis.
5. Operation with RHC No. 2 functional through redundant set of sws.
6. Close direct ullage cbs one at a time to isolate the failure within the DIR ULL pb. DIR ULL MNA powers quad B/D. MNB powers quad A/C jets. This will provide 2-jet direct ullage.

6 VEHICLE DYNAMICS OSCILLATING & DIVERGING



REMARKS

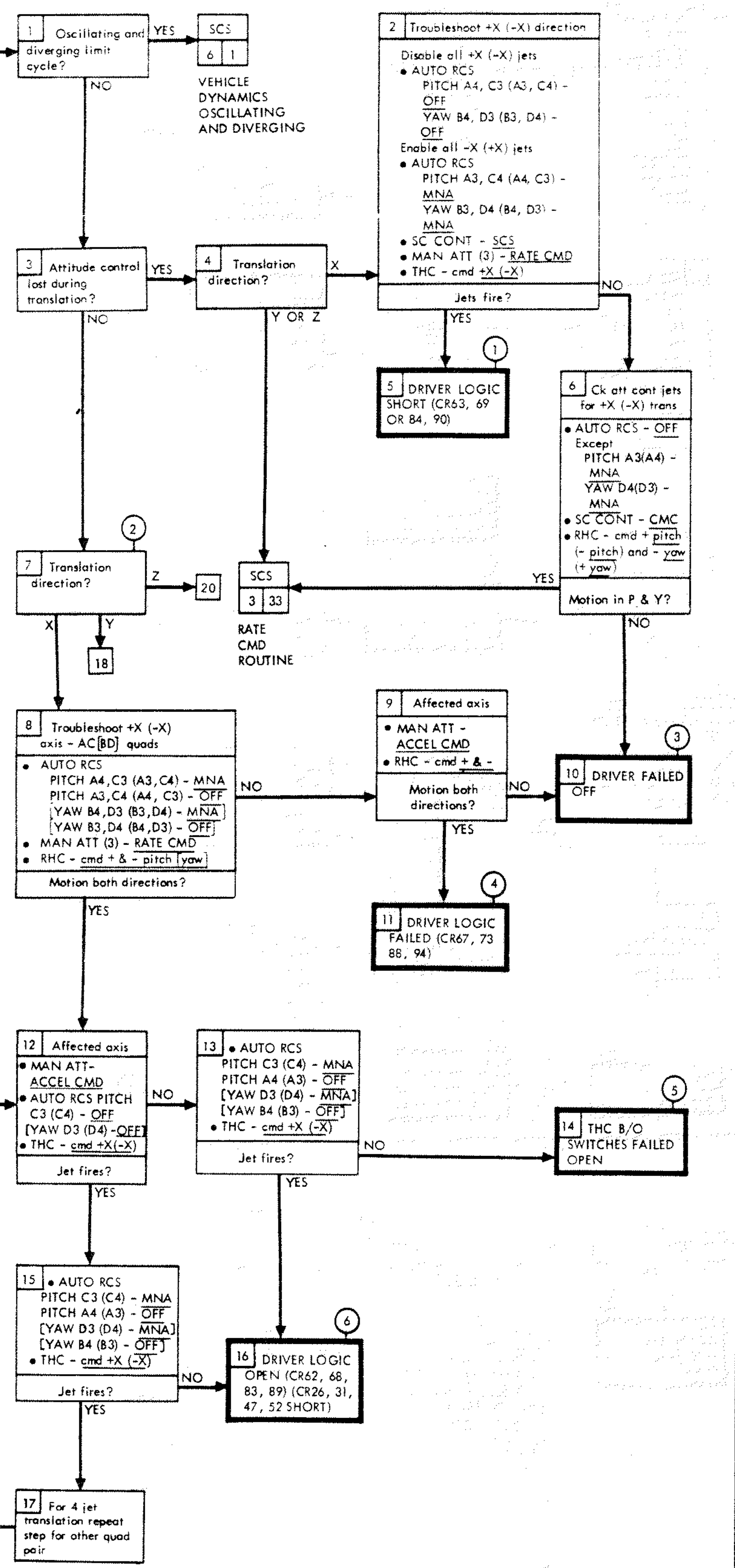
1. SCS ball drive lost in affected axis in RATE 2 or ATT 1 RATE 2. EMS-RSI erroneous after .05 G if yaw or roll, unless switched to RATE 1.
2. No SCS auto ΔV if pitch or yaw; if in roll SCS auto ΔV possible if BMAG mode - ATT 1 RATE 2 & LIM CYCLE - ON.
3. This failure noticeable only if BMAG 2 power is off.
4. Displays & RATE 1 unaffected.
5. For affected axis all rate damping lost. RATE CMD response similar to ACCEL CMD.

SM-2A-1954F

SYMPTOM	PROCEDURE	REMARKS

SCS

7 ABNORMAL VEHICLE DYNAMICS DURING TRANSLATION



REMARKS

1. This failure causes translation jets opposite to selected direction to fire. Attitude control during translations will be lost in one axis (pitch or yaw). For + or -X trans, disable thrusters in affected axis and control attitude with direct. (Translations will be 2 jet.) Or for +X trans, use DIR ULL and control attitude with direct.

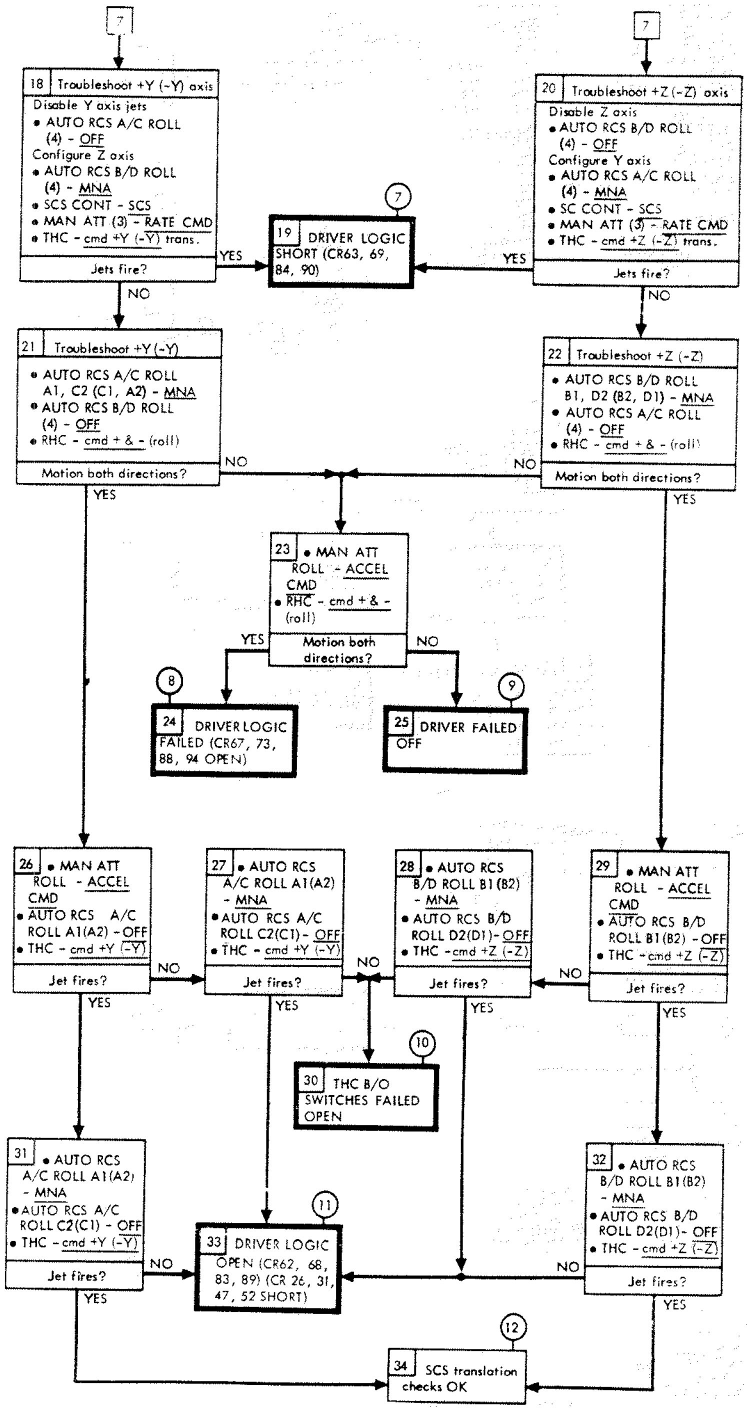
2. If CMC is available, operation of B/O switches in THC may be checked per G&N 3 step 1.

3. All auto coil capability lost for this thruster. Direct available.

4. Affected jet lost for SCS RATE CMD, MIN IMP and auto coil translations. ACCEL CMD and G&N modes unaffected.

5. Translation capability lost in affected axis. If problem is in the +X axis, direct ullage capability remains.

6. Affected jet lost for all auto-coil translations. Rotation capability unaffected.

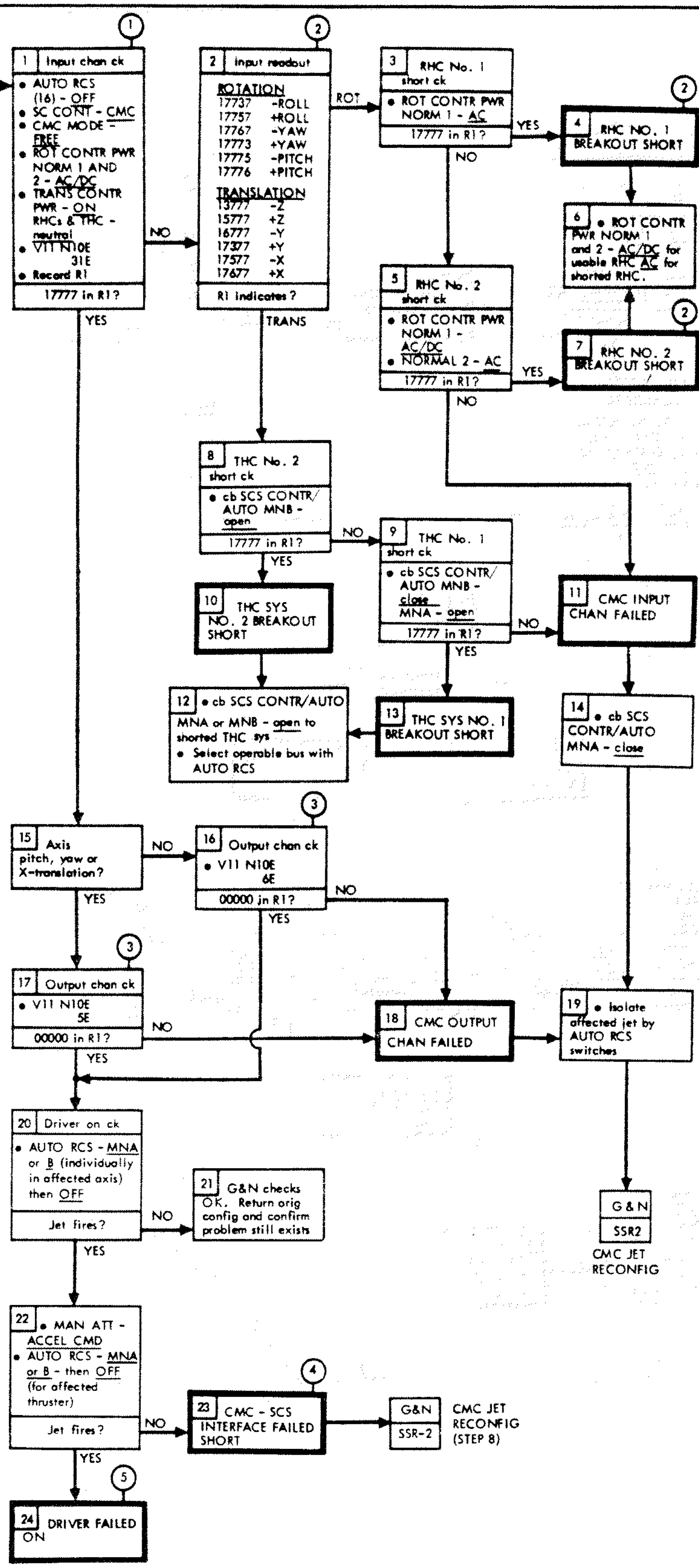
SYMPTOM	PROCEDURE	REMARKS
SCS 7 (Cont)		(7) One direction of Y or Z translation lost. (8) Affected jet lost for SCS RATE CMD, MIN IMP and auto coil translations. ACCEL CMD and G/N modes unaffected. (9) All auto coil capability lost for this thruster. Direct available. (10) Translation capability lost in affected axis. If problem is in the +X axis, direct ullage capability remains. (11) Affected jet lost for all auto-coil translations. Rotation capability unaffected. (12) Abnormal dynamics may be due to thruster degradation.

SM-2A-1956E

SYMPTOM	PROCEDURE	REMARKS

G&N

1 RCS FAILED ON



REMARKS

(1) An R1 of 17777 indicates no jet commands into CMC.

(2) Direct switches in affected RHC still functional. Locking an RHC mechanically opens breakout switches.

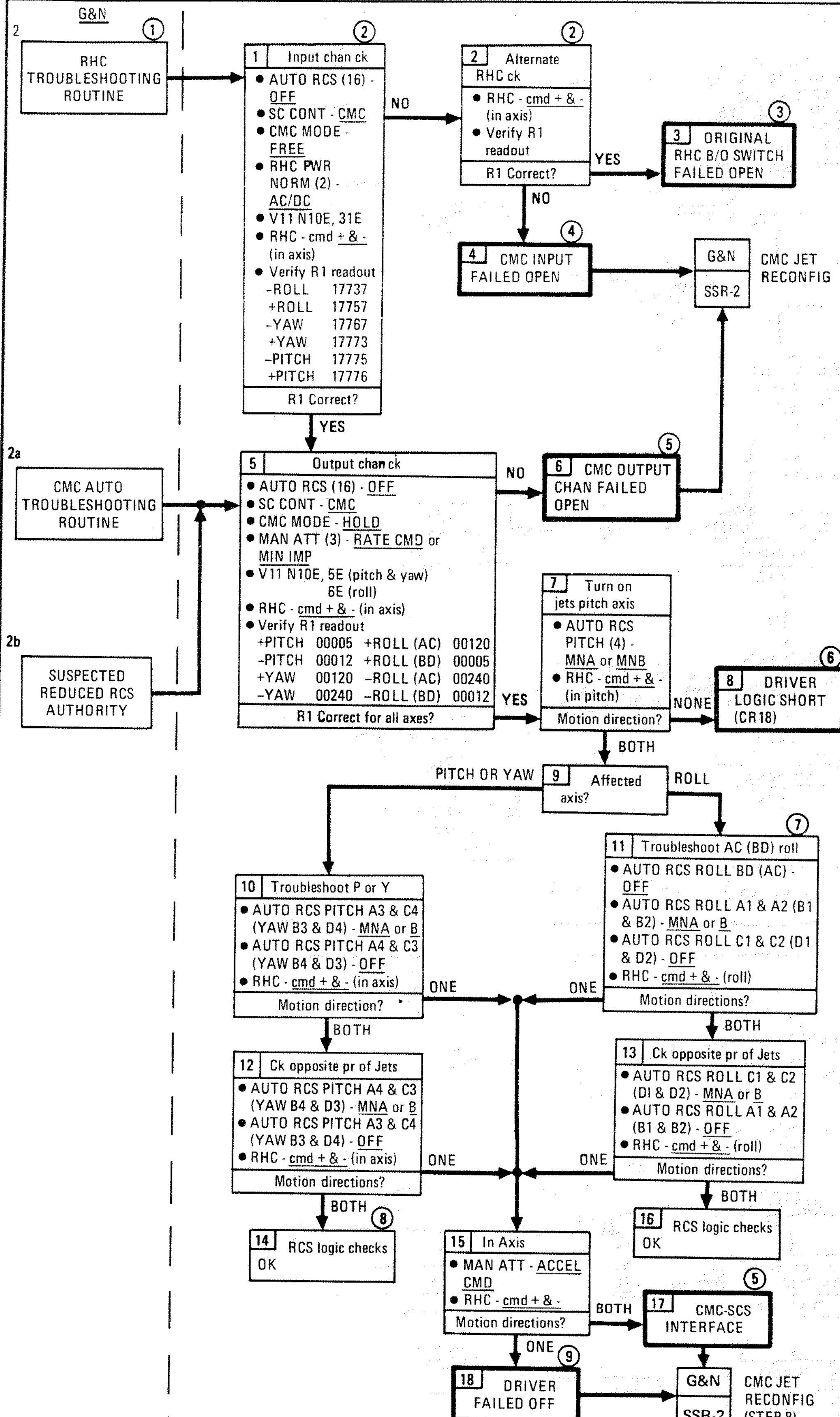
(3) An R1 of 00000 indicates no jet commands from computer.

(4) Affected thruster(s) lost for all G&N control modes. SCS control mode and direct unaffected.

(5) Affected thruster lost for all auto-coil operations. Direct uneffected.

SM-2A-1820H

SYMPTOM	PROCEDURE	REMARKS



REMARKS

(1) Assumes DAP data load has been verified.

(2) Command RCS maneuvers within soft stop region.

(3) Use alternate RHC. Direct unaffected but BMAG caging signal lost.

(4) RHC control (G&N) of affected thruster lost. CMC AUTO and MIC modes unaffected.

(5) All CMC cont to affected thruster lost. SCS modes and direct unaffected.

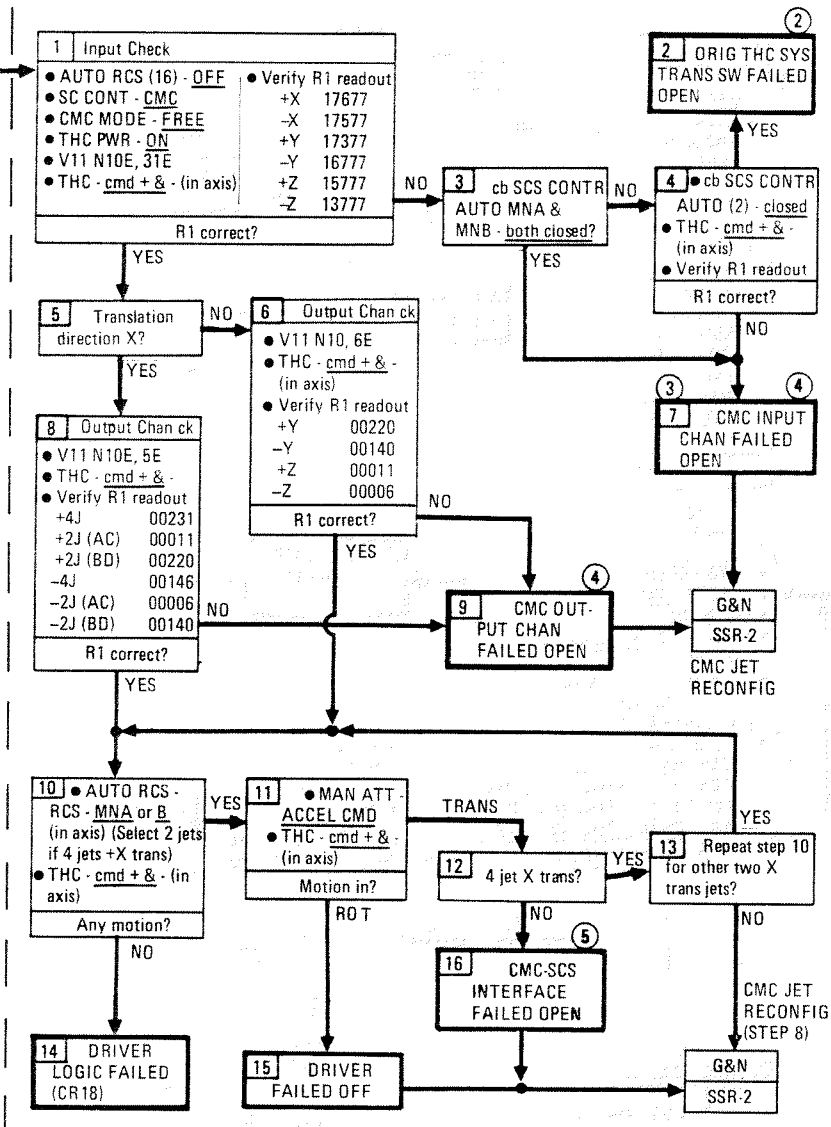
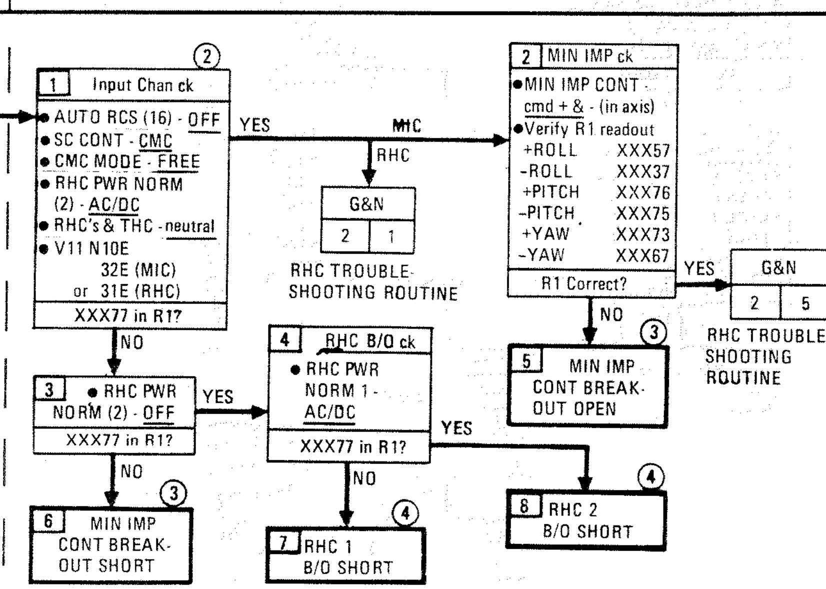
(6) All CMC modes lost when SC CONT - CMC. SCS modes and direct unaffected.

(7) If DAP is configured for B/D roll, replace all references to AC with BD.

(8) Reduced authority may be caused by thruster degradation.

(9) Affected thruster lost for all SCS and CMC modes. Direct mode unaffected.

SM-2A-2264A

SYMPTOM	PROCEDURE	REMARKS
G&N (1) 3 THC TROUBLE-SHOOTING ROUTINE		(1) Assumes DAP data load has been verified. (2) Check cb SCS CONTR AUTO MNA and MNB - close prior to future THC cmd. If MNB cb open, original THC switch failed in system A; if MNA cb open, original THC switch failed in system B. (3) The remote possibility of both THC system translation switches failed open can be determined with the SC CONT - SCS. (4) Translation lost in CMC modes for affected directions. (5) All CMC control to affected thruster lost. SCS modes and direct unaffected.
4 MIN IMP CONT TROUBLE-SHOOTING ROUTINE (1)		(1) Assumes DAP Data Load has been verified. (2) An R1 of XXX77 indicates no input commands to CMC. (3) CMC MIN IMP lost for controller in LEB. CMC or SCS MIN IMP available with RHC. (4) CMC & SCS MIN IMP lost for affected RHC. CMC MIN IMP available with MIC in LEB. Also lost, FDAI att error & att control (BMAG caged in axis). MTVC pitch & yaw not affected. During SCS-SPS thrusting, have FDAI att errors and control after IGN 2 signal.

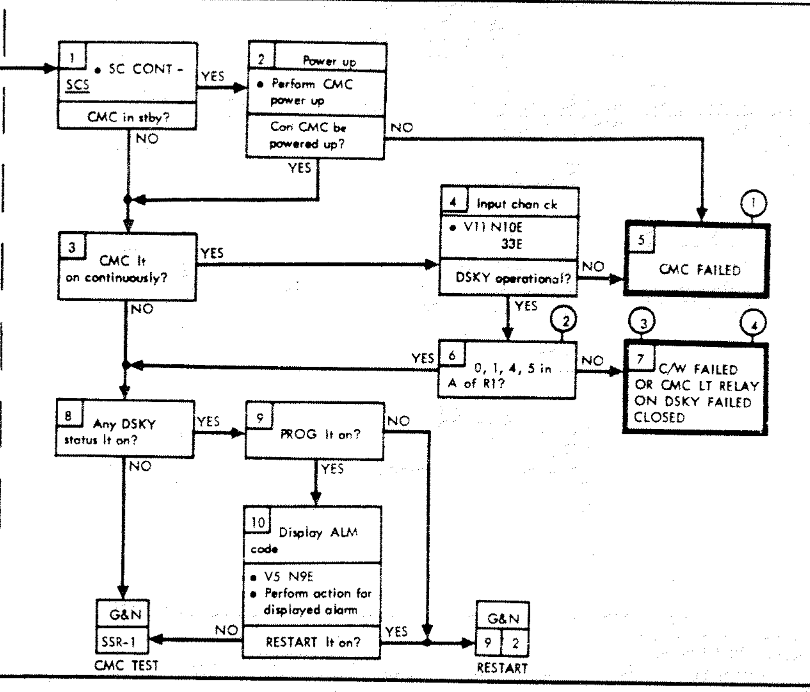
SM 2A-2263

SYMPTOM	PROCEDURE	REMARKS

G&N

5 CMC — RED

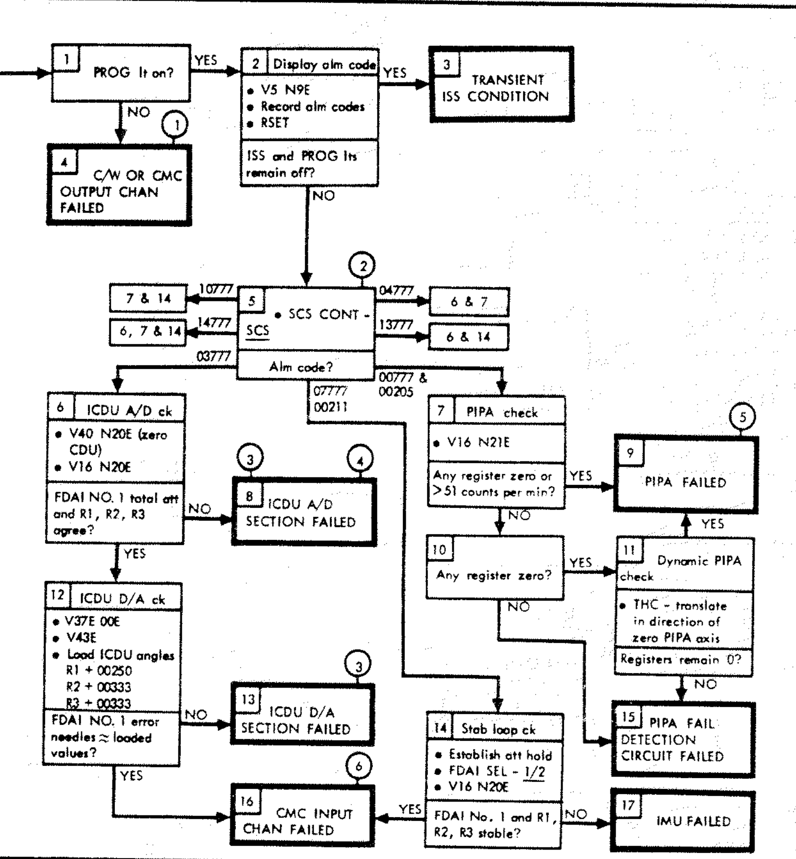
Lt on if:
- CMC prime pwr fails
- Scaler fails
- Counter fails
- Repeated restarts



1. All CMC functions lost.
2. The R1 readout indicates a CMC FAIL signal to CMC.
3. Subsequent CMC malfunction indication from unaffected CMC light.
4. If the LEB CMC lt is on, all gyro torquing and PIPA capability lost. CMC monitor and control of both TVC and entry lost.

6 ISS — RED

Lt on if:
- IMU fails
- ICDU fails
- PIPA fails during thrust



1. Subsequent ISS malfunction indications from unaffected ISS lt.
2. The following alarm codes are generated by the listed failures (or by transient fail discretes):
   - 04777 - PIPA and ICDU fail
   - 10777 - PIPA and IMU fail
   - 13777 - IMU and ICDU fail
   - 14777 - PIPA, IMU and ICDU fail

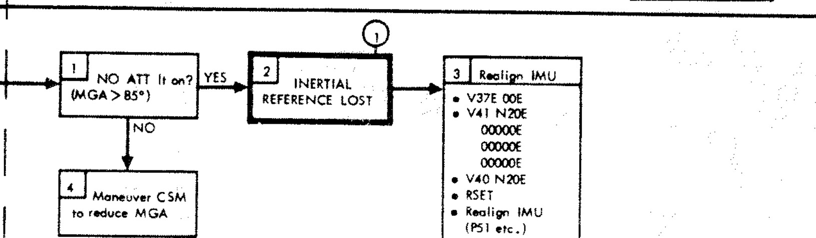
   If any of these alarm codes occur, proceed sequentially to each of the steps indicated. A "no" answer to each step is indicative that a transient fail discrete has been generated.
3.

Function Remaining	A/D Failure	D/A Failure
Fine align	NO	YES
Coarse align	NO	NO
Att err signal	NO	NO
Total att to FDAI	YES	YES
Gmbl angles to CMC	NO	YES
IMU stabilization loop	YES	YES
Cage mode	YES	YES
IMU fail detect ckt	YES	YES
Coarse align in gmbl lock	NO	YES

4. CMC can perform functions not requiring IMU inputs. After each maneuver, state vectors must be updated via P27.
5. CMC monitor and control of both TVC and entry lost.
6. Affects assurance of an ISS command. Subsequent indicator of an ISS failure loss.

7 GIMBAL LOCK — YELLOW

Light on if:
MGA > 70°



1. IMU in coarse align and must be realigned to a new inertial reference.

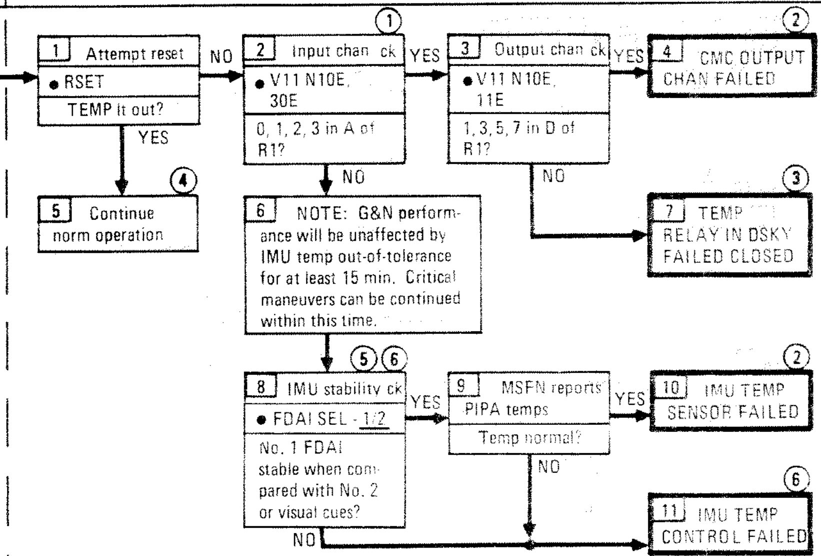
SYMPTOM	PROCEDURE	REMARKS

G&N

8 TEMP

YELLOW

Light on if:
IMU temperature is out of limits <126 or >134°F.

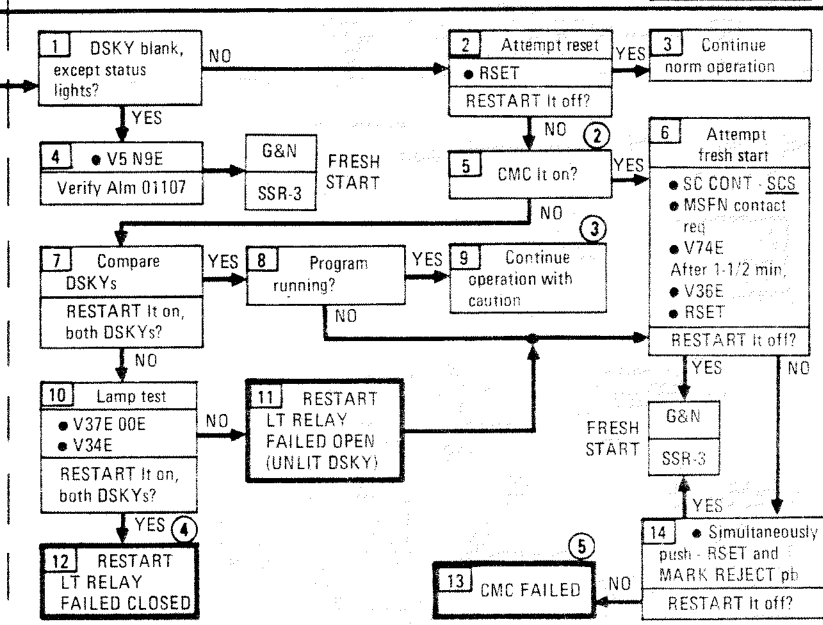


1. This R1 readout indicates IMU temp within limits.
2. All IMU temp abnormal indications lost. Temp available from MSFN only.
3. IMU temp abnormal indication available from unaffected DSKY.
4. Transient abnormal condition.
5. Assumes normal operation of No. 1 FDAI has been verified.
6. IMU may be used as long as FDAI No. 1 indicates that the IMU is stable.

9 RESTART

YELLOW

Lighted by any of the following:
PARITY FAIL
RUPT LOCK
TC TRAP
NIGHT WATCHMAN
or VOLTAGE FAIL

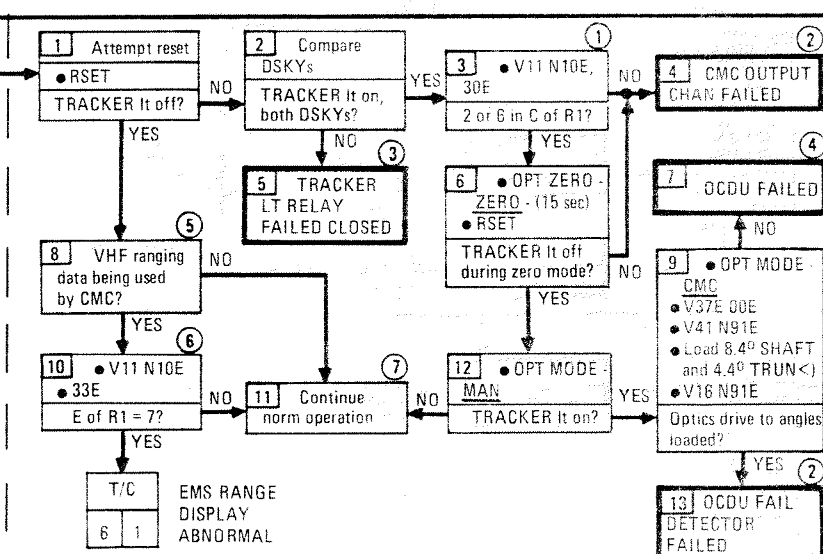


1. If PROG lt on, display the alarm code and perform the required action before proceeding.
2. Restarts at a higher rate than ≈1/sec will trigger CMC light. Restarts at a rate higher than ≈1/2 second will sustain CMC light.
3. Recurring restarts at a rate insufficient to trigger CMC light.
4. Restart indication available from unaffected DSKY.
5. All CMC functions lost.

10 TRACKER

YELLOW

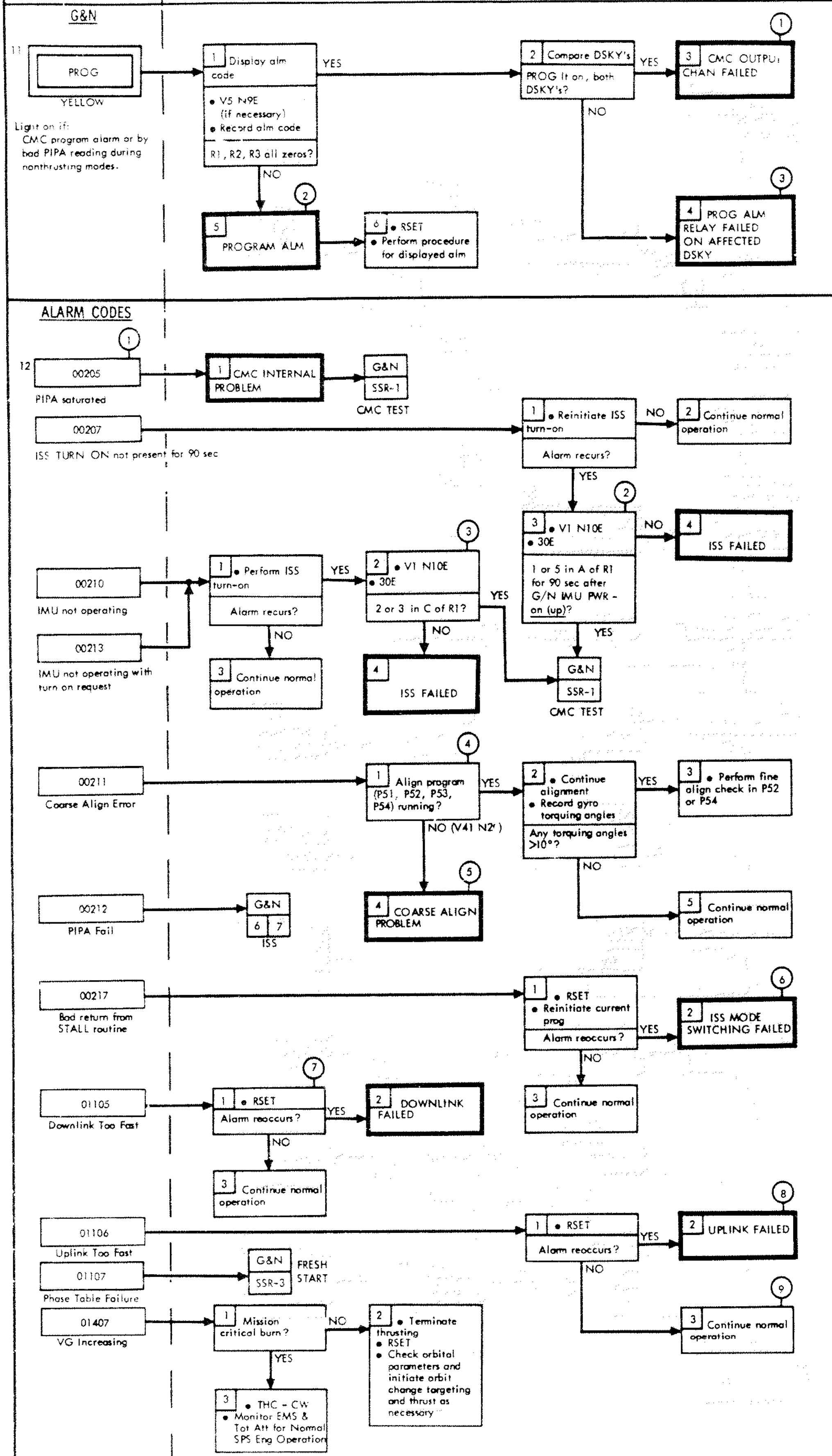
Light on if:
Optics CDU failed or VHF ranging data missing or no good.



1. This R1 readout indicates on OCDU failed.
2. All tracker abnormal indications lost.
3. Tracker abnormal indications available from unaffected DSKY only.
4. Use alternate IMU alignment program (P53 and P54). ISS and CMC unaffected. CMC control of G&N ΔV lost. TVC DAP attitude error still usable.
5. If caused by VHF ranging data no good, the light will return on in < 1 min (CMC samples VHF ranging data every minute).
6. This R1 readout indicates a VHF ranging data no good input to the CMC.
7. Transient abnormal condition.

SM-2A-2262

SYMPTOM	PROCEDURE	REMARKS



REMARKS

(1) PROG light failed on. Program alarm indication available by keying V5 N9E, if not displayed as a main alarm.

(2) Program alarms are of 3 classes:
a. Main alarm - Alarm code displayed. Program halts awaiting crew action.
b. Side alarm - Alarm code not displayed. Program continues.
c. Restart alarm - Alarm code not displayed. Program executes a restart.
CMC can store multiple alarms. First alarm appears in R1; second in R2; last in R3.

(3) Program alarm indication available from other DSKY.

(1) Assumed to have occurred without an ISS light.

(2) This R1 readout checks the presence of a turn-on request from the IMU.

(3) This R1 readout checks the presence of an IMU operate discrete from the IMU.

(4) 00211 will occur only during coarse alignment, either by an alignment program or by DSKY command (V41 N20).

(5) IMU must be aligned by an alignment program—i.e., by gyro torquing rather than coarse align.

(6) IMU usable only as a backup attitude reference.

(7) Downlink data transmitted at time of alarm may not be correct. Update must be manually verified.

(8) Perform subsequent CMC ground updates by voice link.

(9) Uplink data being sent when alarm occurred should be transmitted.

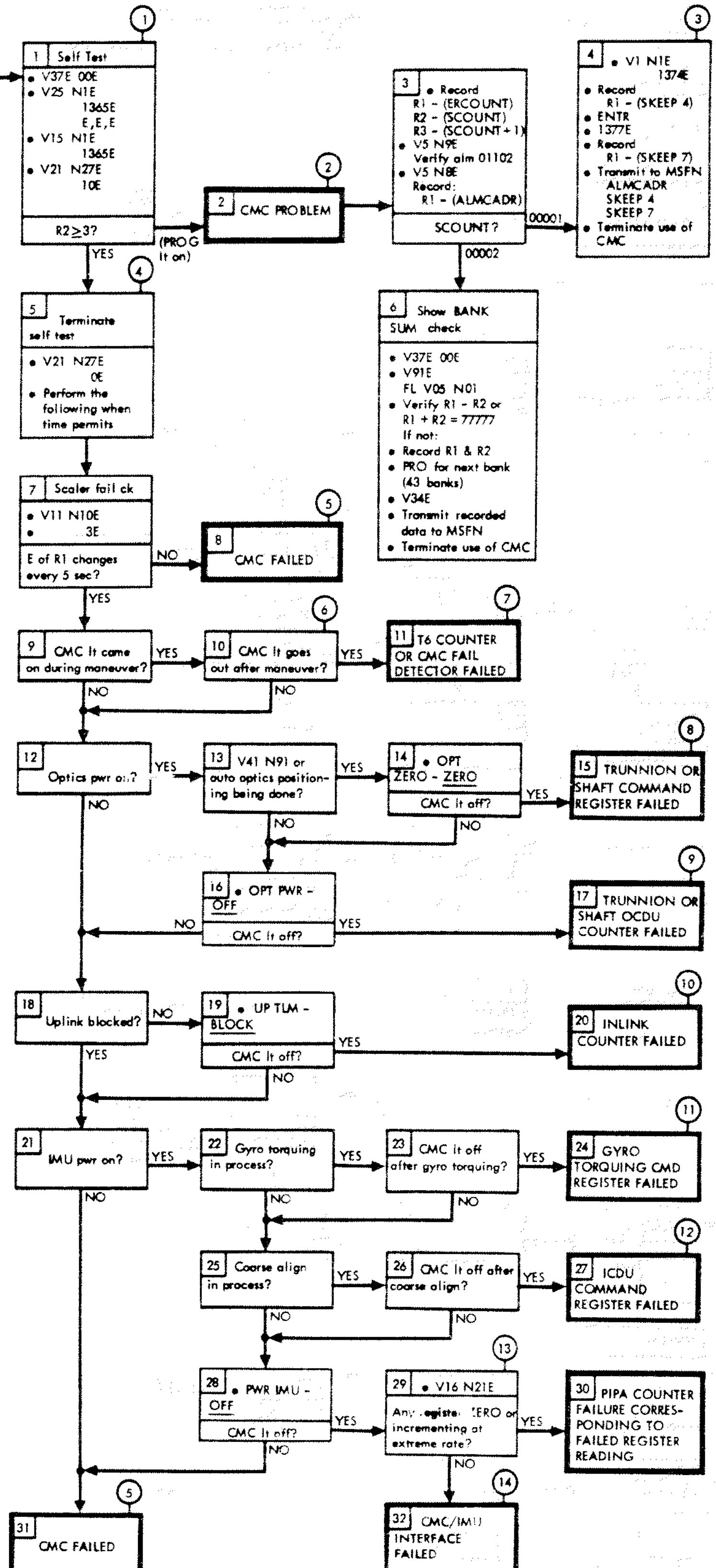
SM-2A-1826E

SYMPTOM	PROCEDURE	REMARKS

SPECIAL SUB ROUTINES

SSR-1

CMC TEST



REMARKS

(1) R2 00001 for 7 SEC
R2 00002 for 43 SEC

(2) Subsequent use of CMC dependent on MSFN evaluation (via downlink) of the succeeding steps in self-test.

(3) Problem is in erasable memory.

(4) CMC self check tests only erasable and fixed memory. Other internal problems cannot be determined by self check.

(5) All CMC functions lost.

(6) Do not use CMC control for attitude maneuvers.

(7) RCS DAP unusable since T6 counter controls DAP jet firing times.

(8) TVC DAP and auto optics positioning lost.

(9) Optics/CMC interface lost. Use alternate LOS marking routine (P53, P54).

(10) CMC uplink unusable.

(11) IMU cannot be fine aligned.

(12) IMU cannot be coarse aligned. Align by caging and/or fine align. CMC attitude error display lost in axis. CMC control of SIVB lost.

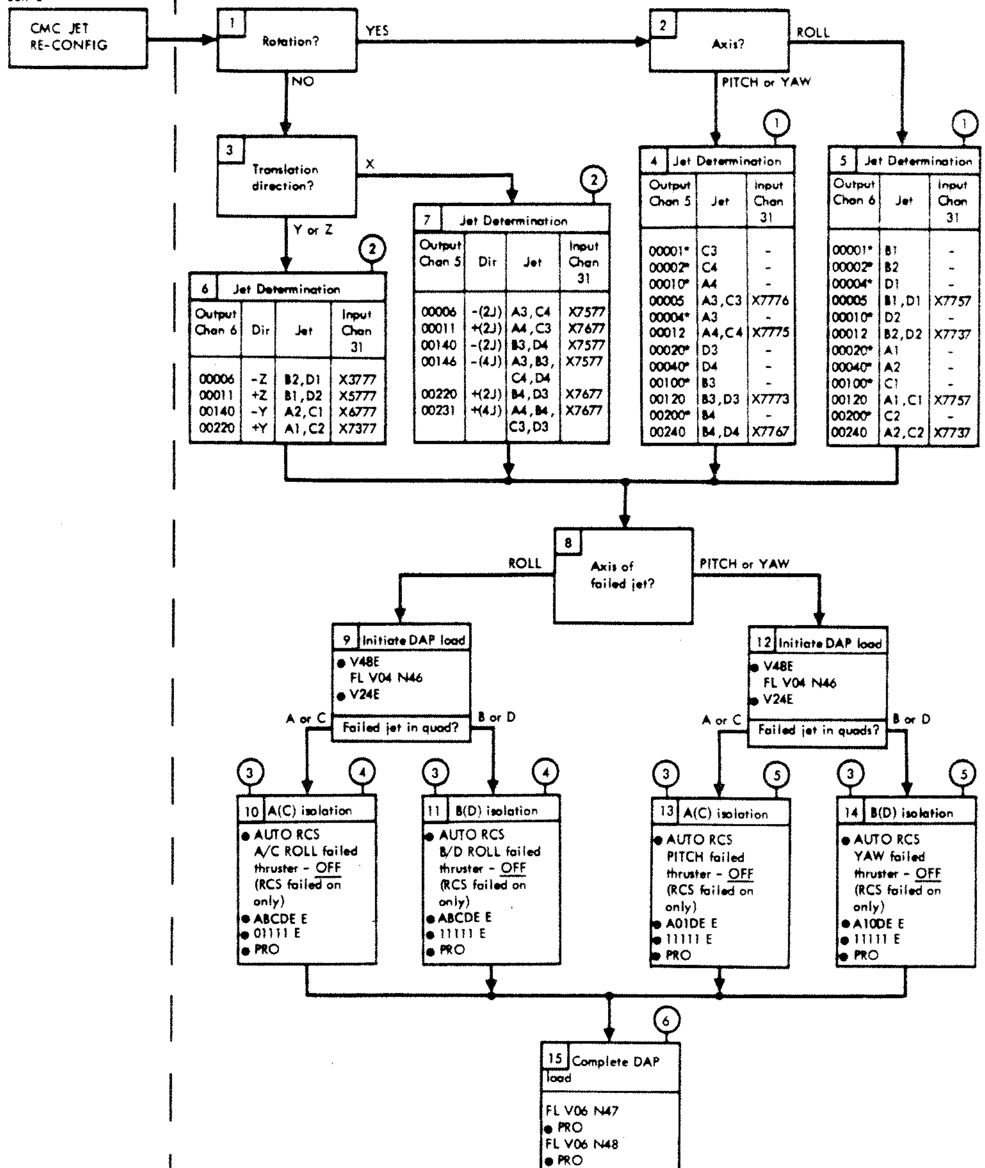
(13) CMC TVC and entry control lost.

(14) IMU usable as attitude reference only.

SM-2A-1827D

SPECIAL SUB ROUTINES	PROCEDURE	REMARKS

SSR-2



6 Jet Determination

Output Chan 6	Dir	Jet	Input Chan 31
00006	-Z	B2,D1	X3777
00011	+Z	B1,D2	X5777
00140	-Y	A2,C1	X6777
00220	+Y	A1,C2	X7377

7 Jet Determination

Output Chan 5	Dir	Jet	Input Chan 31
00006	-(2J)	A3,C4	X7577
00011	+(2J)	A4,C3	X7677
00140	-(2J)	B3,D4	X7577
00146	-(4J)	A3,B3, C4,D4	X7577
00220	+(2J)	B4,D3	X7677
00231	+(4J)	A4,B4, C3,D3	X7677

4 Jet Determination

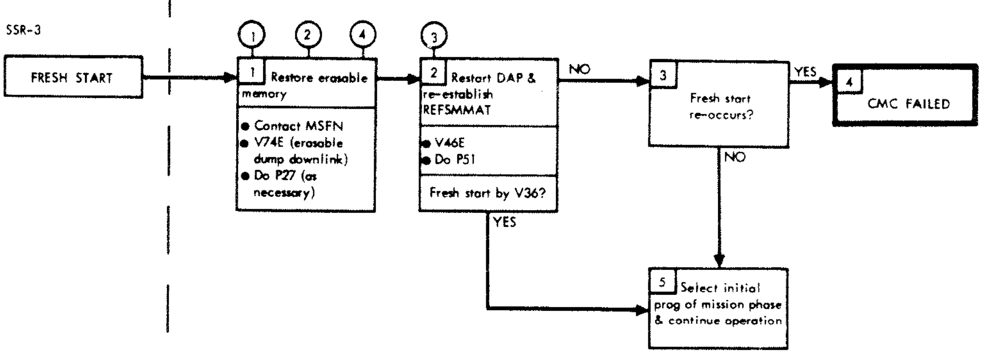
Output Chan 5	Jet	Input Chan 31
00001*	C3	-
00002*	C4	-
00010*	A4	-
00005	A3,C3	X7776
00004*	A3	-
00012	A4,C4	X7775
00020*	D3	-
00040*	D4	-
00100*	B3	-
00120	B3,D3	X7773
00200*	B4	-
00240	B4,D4	X7767

5 Jet Determination

Output Chan 6	Jet	Input Chan 31
00001*	B1	-
00002*	B2	-
00004*	D1	-
00005	B1,D1	X7757
00010*	D2	-
00012	B2,D2	X7737
00020*	A1	-
00040*	A2	-
00100*	C1	-
00120	A1,C1	X7757
00200*	C2	-
00240	A2,C2	X7737

1. Starred (*) outputs are single jet commands. For RCS failed on, the failed jet is the indicated jet. For output channel failed open, the failed jet is the corresponding jet in the rotational couple, e.g. command + pitch. Should observe 00005 in chan 5 (A3, C3 + pitch couple). If observe 00004, C3 can not be commanded on by CMC.
2. If R1 (output chan) contains a number not listed, determine the failed jet from the R1 (output) readout when a rotation command is given.
3. In R1, A is vehicle configuration:
   0 - No DAP
   1 - CSM only
   2 - CSM + LM (asc + des)
   3 - CSM + SIVB
   6 - CSM + LM (asc only)
   In R1, B is quad A/C for X translation:
   0 - FAIL A/C
   1 - USE A/C
   In R1, C is quad B/D for X translation:
   0 - FAIL B/D
   1 - USE B/D
   In R1, D is DAP deadband
   0 - 0.5°
   1 - 5.0°
   E is the DAP rate
   0 - 0.05°/sec
   1 - 0.20°/sec
   2 - 0.5°/sec
   3 - 2.0°/sec
   In R2, A is roll selection
   0 - Use B/D
   1 - Use A/C
4. Translation (Y or Z) will be single jet and result in excessive RCS prplnt consumption.
5. Rotations (pitch or yaw) will be single jet. X translations will be 2 jet.
6. N47 and N48 display other DAP parameters assumed to be correct.

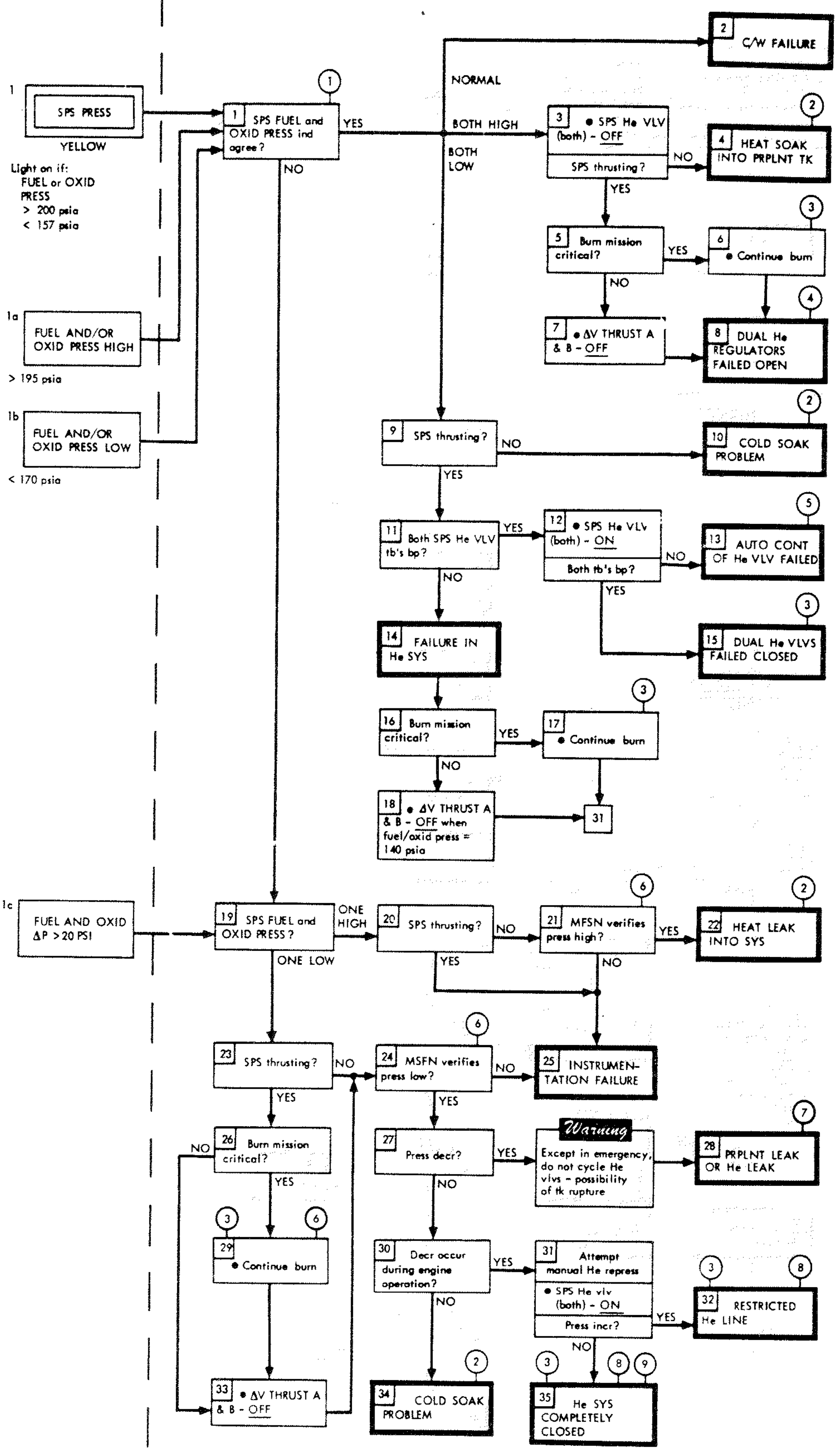
SSR-3



1. State vector and CMC time should be updated. All nonpad-loaded parameters, except time & state vector, will be properly updated by CMC programs in their proper sequence as if CMC had just been turned on when fresh start occurred.
2. Extended V74 permits MSFN to examine all pertinent erasable locations to determine if any parameters need reloading.
3. DAP is shut off by fresh start & must be re-initiated by V46.
4. REFSMMAT, SURF FLAG, LMOONFLG, CMOONFLG, and NODOPO1FLAG are not changed by a fresh start. All other flagwords are reset by fresh start. DRIFTFLG (bit 15, flagword 2) should be set by:
   V25 N7E
   76E
   40000E
   1E
   For all others proper flags are set again by performance of CMC programs in normal sequence.

SM-2A-1828G

SYMPTOM	PROCEDURE	REMARKS



REMARKS

(1) Normal operating press is 170 - 195 psia. MSFN will use fuel and oxid telemetered press data to backup onboard indications.

(2) Attempt temp control by orienting CSM if possible.
a. Fuel & oxid press high, orient -X axis toward deep space.
b. Fuel press high, orient -Z, -Y quadrant toward deep space.
c. Oxid press high, orient +Y, +Z quadrant toward deep space.

(3) Engine chugging may occur if SPS Pc is < 60 psia. Corresponding fuel & oxid press is ≈ 85 psia.

(4) Control fuel & oxid press between 175 and 185 psi by manual actuation of He sw. Individual activation of the He switches will identify the failed regulator leg. Flow through failed regs will exceed the capability of the relief vlv.

(5) Open and close He vlvs manually for each burn.

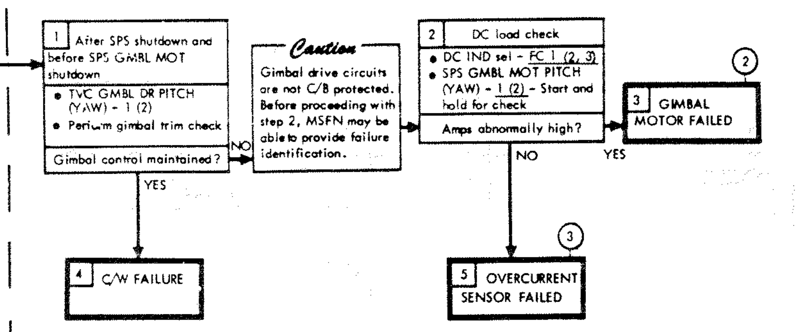
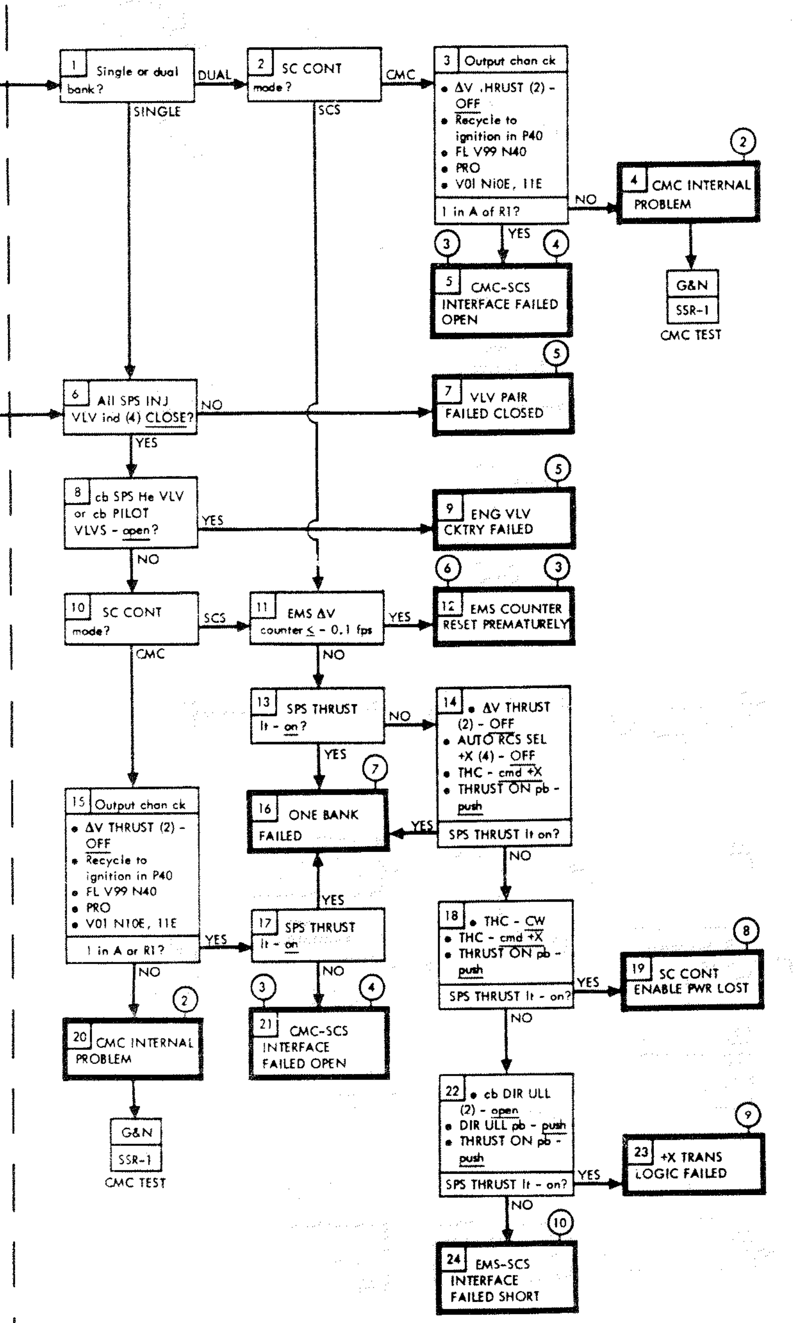
(6) **Caution**
ΔP between SPS FUEL and OXID PRESS should not exceed 20 psi during a burn. Degraded performance, rough combustion, and/or engine failure may result.

(7) Prior to emergency SPS operation, manually repressurize propellant tanks.

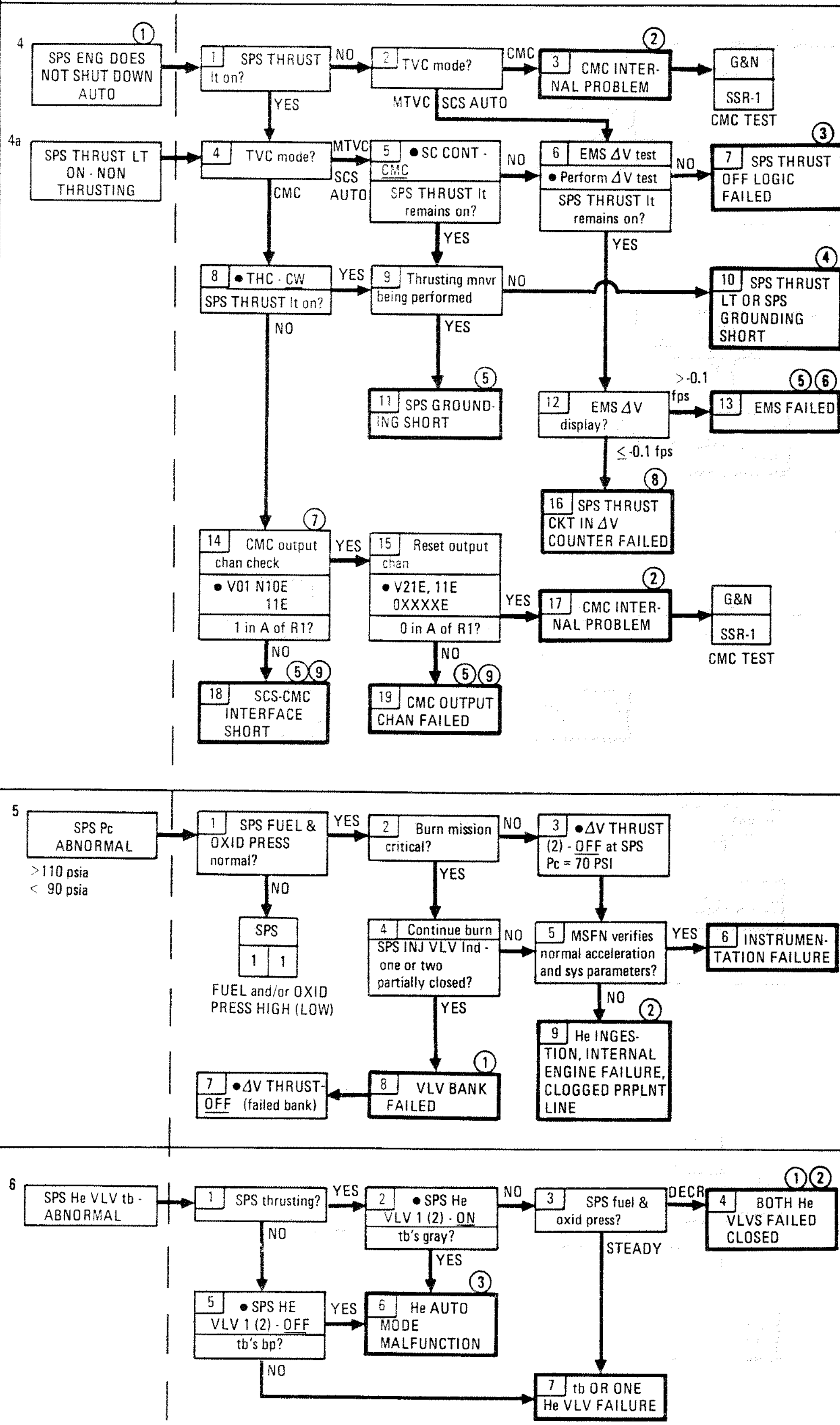
(8) All subsequent SPS burns should be made with SPS He VLV (both) - OFF to minimize ΔP between fuel and oxidizer.

(9) When fuel and oxidizer press decreases to 140 psia, place OXID FLOW VLV - DECR.

SM-2A-1459K

SYMPTOM	PROCEDURE	REMARKS
2 (1) PITCH (YAW) GMBL 1 (2) YELLOW. Light on if: Overcurrent occurs in respective drive motor or gimbal actuator.		(1) Automatic transfer from the primary system to secondary occurs with an overcurrent provided the TVC GMBL DR switch is at AUTO. (2) For subsequent ΔV's, place TVC GMBL DR sw to alternate servo position in affected axis. (3) Selected gimbal motor is operational when SPS Pitch (Yaw) 1 (2) cb is opened while affected gimbal motor switch is held at START. However, overcurrent protection and switch-over capability will not be available. Close the cb to turn off the gimbal motor.
3 (1) SPS PREMATURE SHUTDOWN 3a NO SPS IGNITION		(1) Troubleshooting assumes original switch positions at time of shutdown. (2) All G&N SPS capability lost. (3) Manual on-off procedure a. At TIG -1 min, SPS THRUST - DIR ON b. At TIG, ΔV THRUST A(B) - NORM c. At TIG +3 sec, ΔV THRUST B(A) - NORM (if dual bank) d. Terminate burn on ΔV or time by ΔV THRUST (2) - OFF. (4) G&N SPS on-off control lost. TVC DAP unaffected. (5) ΔV capability lost for affected bank. (6) Perform EMS ΔV test and if OK, use ΔV counter to monitor burn. Use manual on-off procedure (Remark 3). (7) Affected bank may still be available using SPS THRUST - DIR ON. Alternate bank unaffected. (8) THC must be CW for SCS ΔV capability. SCS auto ΔV lost. (9) For SCS ΔV use DIR ULL pb for eng on initiation (+X TRANS logic function lost). (10) CMC ΔV capability unaffected. SCS ΔV auto on-off lost. For SCS ΔV use manual on-off procedure (Remark 3).

SYMPTOM	PROCEDURE	REMARKS



Remarks (4, 4a)

(1) Assumes SPS engine was shut down with the ΔV thrust switches.

(2) All G&N SPS capability lost.

(3) SCS auto cutoff lost, use manual thrust on-off procedure presented in Remark 5.

(4) Since failure could be SPS thrust lt on only, for ΔV's perform single bank ignition per Remark 5.

(5) Auto thrust on-off lost for one and possibly both banks. Use manual on-off procedure:
- a. At TIG-1 min, SPS THRUST DIR ON
- b. At TIG, ΔV THRUST A(B) - NORM
- c. At TIG +3 sec, ΔV THRUST B(A) - NORM (if dual bank)
- d. Terminate burn on ΔV or time by ΔV THRUST (2) - OFF

or for single bank operation:
At TIG -2 sec, ΔV THRUST (alt bank) - NORM
- a. If SPS lts, auto thrust on-off lost for both banks, use manual on-off procedure above.
- b. If no SPS ign, auto on-off remains for alt bank.

(6) SCS ΔV capability remains but must terminate burn with time. Perform entry self test to determine EMS capability for entry.

(7) This step must be done while still in P40. After check has been made exit P40 to terminate average G.

(8) SCS auto cutoff lost. Manual cutoff required.

(9) G&N auto eng on-off control lost only.

Remarks (5)

(1) Failed bank should not be used except in an emergency.

(2) SPS engine operable until engine indications require shutdown. Engine chugging may occur if SPS Pc is <60 psi.

Remarks (6)

(1) When fuel and oxidizer press decreases to 140 psia, place OXID FLOW VLV - DECR.

(2) SPS engine operable until engine indications require shutdown. Engine chugging may occur if Pc is <60 psi. Corresponding fuel & oxid pressure is ≈85 psia.

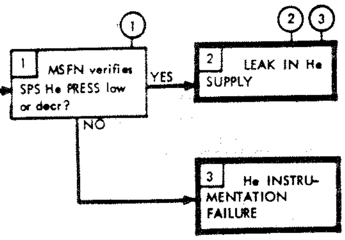
(3) Open and close He valves manually for each burn.

SM-2A-1461L

SPS MALFUNCTION

SYMPTOM	PROCEDURE	REMARKS

7 He PRESS LOW OR DECR

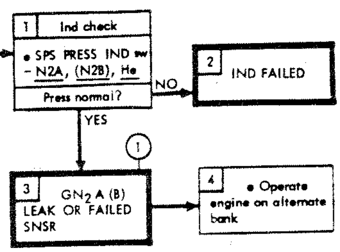


1. MSFN will monitor redundant He press instrumentation.
2. He depletion imminent. SPS engine operable until engine indications require shutdown. Engine chugging may occur if SPS Pc is <60 psi. Corresponding fuel & oxid pressure is ≈85 psia.
3. When fuel and oxidizer press decreases to 140 psia, place OXID FLOW VLV - DECR.

8 GN2 A (B) PRESS LOW

<400 PSI

8a SPS INJ VLV PARTIALLY OPEN

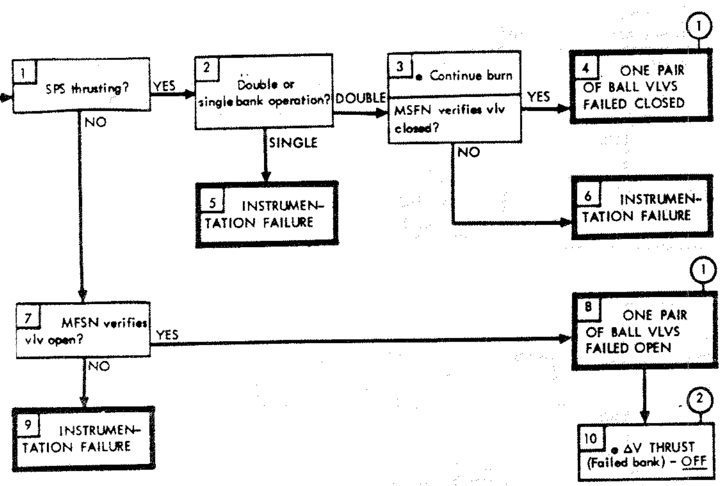


1. Operation at <350 psi results in partially open ball vlvs and hazardous engine operation.

9 SPS INJ VLV IND ABNORMAL

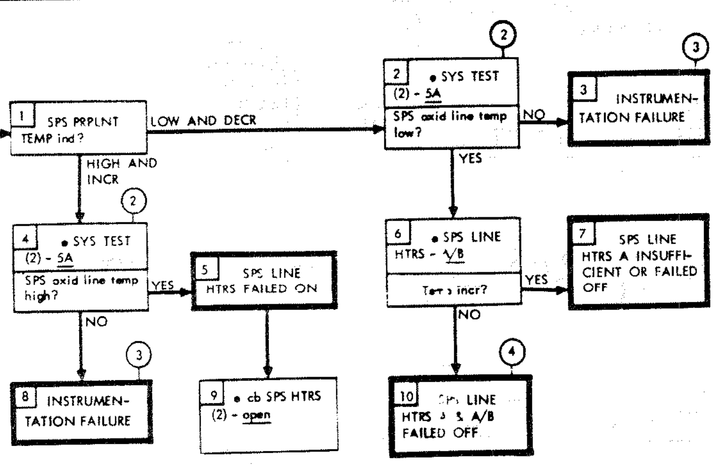
One open during non-thrusting

One or two closed during burn period (or burn attempt)



1. SPS operable on redundant bank if one bank failed.
2. Failed bank should not be used except in an emergency.

10 NO PRPLNT TEMP CONTROL (1)



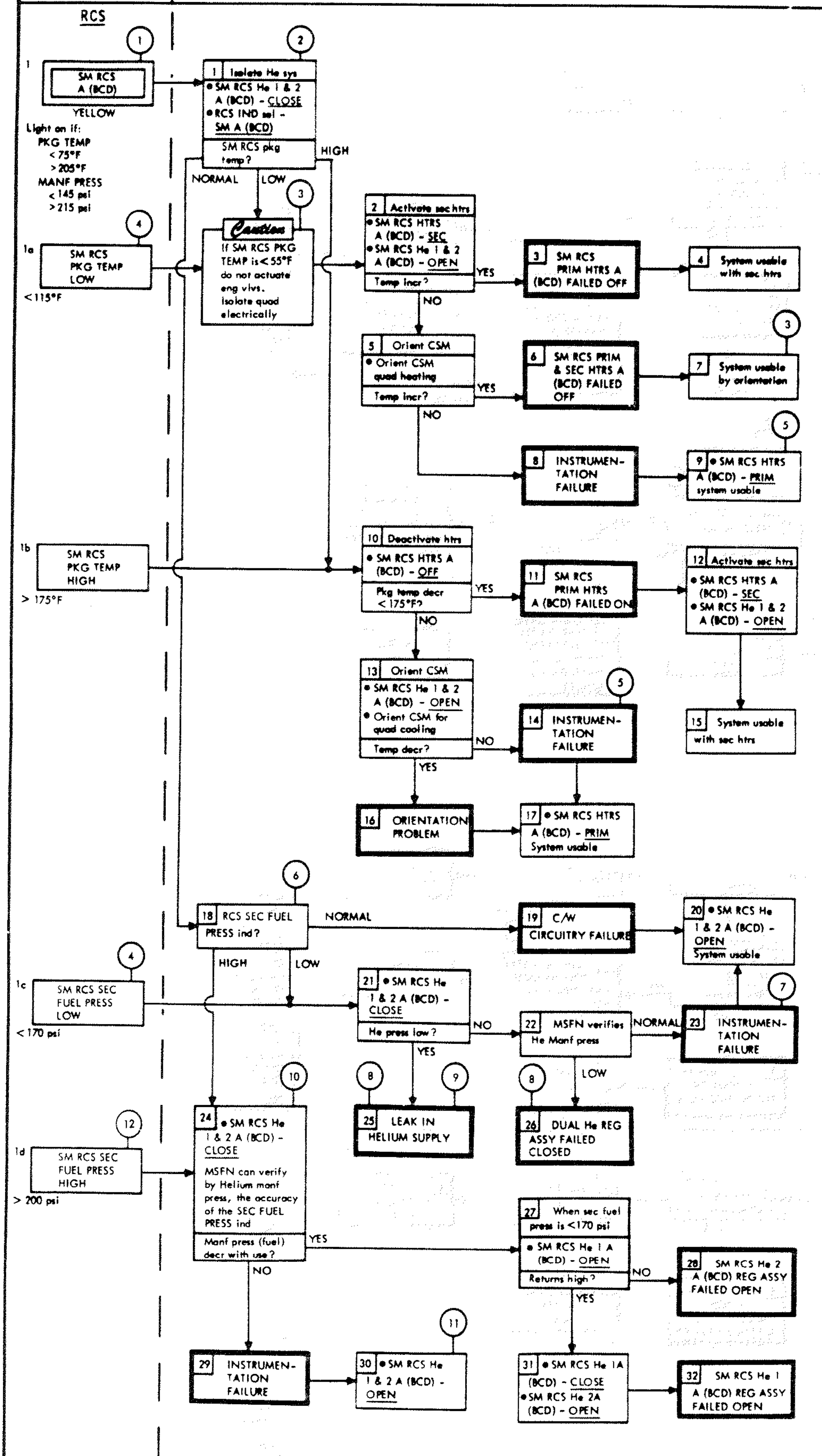
1. Normal range 45-75°F.
2. Assumes CSM not in inertial hold mode which might normally result in differences between SPS prplnt temp and SPS oxid line temp.
3. Use oxid line temp for SPS prplnt temp.
4. Prplnt temp may be incr by CSM orientation or by firing SPS engine. At 27°F the propellants become slushy and the fuel & oxid ratio becomes unpredictable.

SM-2A-1462J

SYMPTOM	PROCEDURE	REMARKS
11 NO RESPONSE OF SPS OXID VLV tb DURING FLOW ADJUST (OXID FLOW VLV PRIM - PRIM)	1 (1) • OXID FLOW VLV INCR - NORM Wait 5 seconds: • OXID FLOW VLV PRIM - SEC • OXID FLOW VLV INCR - INCR (DECR) SPS OXID FLOW VLV tb correct? NO → 2 OXID FLOW VLV tb FAILED → 3 (2) • OXID FLOW VLV INCR - NORM Wait 5 seconds: • OXID FLOW VLV PRIM - PRIM • OXID FLOW VLV INCR sw - as desired YES → 4 (3) PRIM OXID FLOW VLV FAILED	(1) OXID FLOW VLV INCR sw cannot operate unless power applied through a thrust on signal or through the SPS QTY TEST sw. If flow vlv position was changed by the SPS QTY TEST sw, % FUEL & % OXID quantity readouts must be returned to original values. (2) The secondary sliding gate vlv must be in the nominal flow position (rather than INCR or DECR) before switching to the prim oxid flow vlv or misalignment of the secondary vlv could make the primary vlv inoperative. (3) Sec vlv has sufficient range to compensate for prim vlv failure in any position and still provide vlv openings for INCR, NORM or DECR oxid flow.
12 (1) (2) SPS OXID UNBAL IND ERRATIC OR PEGGED	1 (3) • PUG MODE - AUX OXID UNBAL ind normal? NO → 2 OXID UNBAL ind check • SPS QTY TEST - 1 for 10 sec, then 2 for 10 sec OXID UNBAL ind normal? NO → 3 OXID UNBAL ind FAILED → 4 (4) Return to normal PUG mode • PUG MODE - PRIM • Perform qty test • PUG MODE - NORM YES (from 1) → 5 PRIM UNBAL SYS FAILED YES (from 2) → 5 PRIM UNBAL SYS FAILED	(1) Assumes qty indicating sys normal. (2) The unbalance meter will behave erratically for approximately 25 seconds after engine ignition. This is caused by propellant dynamics. (3) Assumes CSM is still thrusting. If thrust has terminated, proceed with step 2. (4) Actuation of SPS QTY TEST sw here will realign digital display to prim sys.
13 SPS OXID (FUEL) QTY IND READOUT ABNORMAL	1 (1) • PUG MODE - AUX % OXID (% FUEL) readout normal? YES → 2 (2) Prim qty test • PUG MODE - PRIM • SPS QTY TEST - 1 • Incr % oxid by 5.0% % Fuel incr by 2.3±1%? YES → 3 CAPACITANCE PROBE FAILED → 6 Use aux sys • PUG MODE - AUX NO → 5 PRIM SYS SERVO AMP FAILED → 6 Use aux sys NO (from 1) → 4 (2) Aux qty test • SPS QTY TEST - 1 • Incr % oxid by 5.0% % Fuel incr by 5±1%? YES → 2 NO → 7 (3) DISPLAY FAILED	(1) Assumes SPS is still thrusting. If thrusting terminated before step 1 is complete, proceed to step 4. (2) Complete thrusting prior to qty test. (3) MSFN must now supply any prplnt quantity data.

SYMPTOM	PROCEDURE	REMARKS

RCS



REMARKS

1. Illumination during boost or immediately following orbit insertion may be due to boost heating.
2. Anticipated PKG TEMP operating range is 115-175°F. Safe operating range is 55-210°F
3. Actuation at < 55°F might result in eng explosion. Four AUTO RCS switches and both ROT CONTR PWR DIRECT switches must be OFF to elec isolate the affected quad. If there were eng vlv actuations while PKG TEMP was < 55°F, close prplnt isolation vlvs in the affected quad. Reactivate the quad only in emergency. If quad is reactivated, the first pulse on each jet should be ≥ 1 second.
4. Sensors powered by cb 3 (Quads A, C) and cb 4 (Quads B, D) INST PWR CONT (pnl 276).
5. Use temp of other quads to estimate the temp of affected quad.
6. Anticipated He operating press is 175-195 psi. In addition to He MANF PRESS, MSFN can read out fuel & oxid manf press of each quad.
7. MSFN must be used for SM RCS SEC FUEL PRESS indication of affected quad.
8. Quad usable until SM RCS SEC FUEL PRESS drop < 75 psi. Place SM RCS PRPLNT A (BCD) - OFF. Firing jets at press < 75 psi may cause eng wall burn-through due to inadequate film cooling.
9. A prplnt leak will not cause low sec fuel pressure when He isolation vlvs are open.
10. Relf vlv burst disk ruptures at 220-236 psi. Relief vlvs open at 225-248 psi and reseats at no less than 220 psi.
11. MSFN must be relied upon for SM RCS SEC FUEL PRESS indications.
12. SM RCS SEC FUEL PRESS may increase to > 200 psia during boost until jets are fired.

SM-2A-1938E

SYMPTOM	PROCEDURE	REMARKS

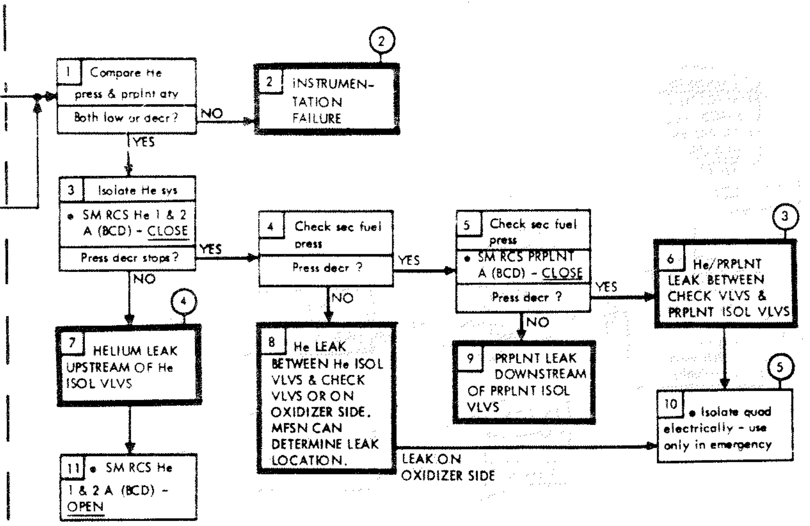
RCS

SYMPTOM

2 SM RCS He PRESS LOW OR DECR (1)

2a SM RCS PRPLNT QTY LOW OR DECR

PROCEDURE



REMARKS

(1) Sensors powered by cb 3 (Quads A, C) and cb 4 (Quads B, D) INST PWR CONT (pnl 276).

(2) He press can be estimated from PRPLNT QTY remaining, or obtained from MSFN.

(3) Differentiation between a helium and prplnt leak not determinable from onboard instrumentation. Subsequent operational capability may be determined with MSFN.

(4) Quad usable until SM RCS SEC FUEL PRESS (fuel) drops to<75 psi. Place SM RCS PRPLNT A (BCD) - CLOSE. Firing jets at press <75 psi may cause engine wall burn-through due to inadequate film cooling.

(5) If prplnt leak is at eng vlv. firing of engine may result in an explosion

---

SYMPTOM

3 CM RCS 1 (2)

YELLOW

Light on if:
MANF PRESS
< 260 psi
> 330 psi

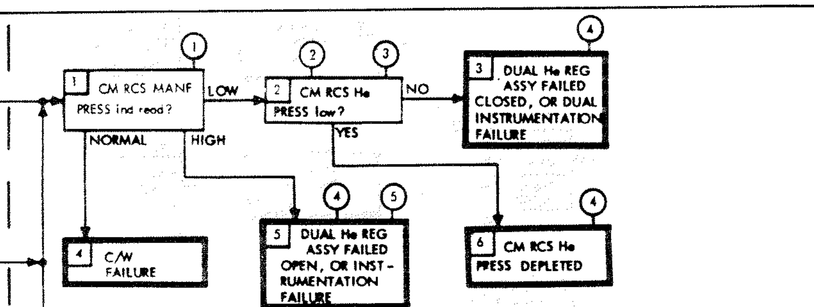
3a CM RCS MANF PRESS HIGH

> 310 psi

3b CM RCS MANF PRESS LOW (3)

< 280 psi SYS PRESS
< 80 psi SYS UNPRESS

PROCEDURE



REMARKS

(1) Anticipated operating range 285-305 psi.

(2) Prior to system pressurization, MSFN must aid in determining failure identification from redundant manifold pressure instrumentation.

(3) All CM RCS sensors for ring 1 (2) powered by cb 1 (cb 2) INST PWR CONT (pnl 276).

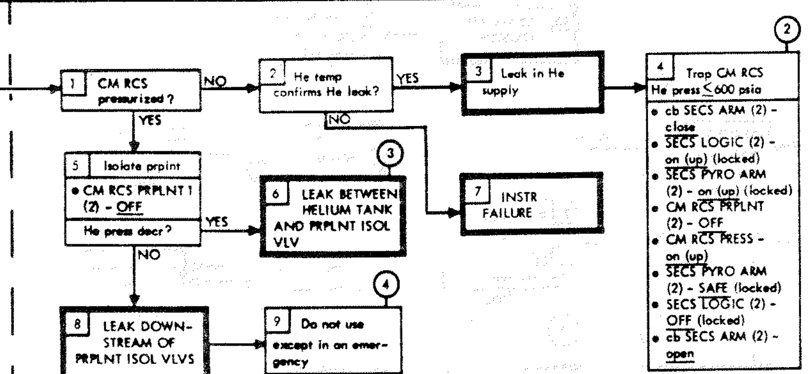
(4) No limit for low fuel and oxid press for safe eng operation (at 65 psi, thrust is approximately 29 pounds).

(5) Relf vlv diaphragm ruptures at 332-348 psi. Relf vlv relieves at 332-360 psi and reseats at 327 psi minimum.

SYMPTOM

4 CM RCS He PRESS LOW OR DECR (1)

PROCEDURE



REMARKS

(1) All CM RCS sensors for ring 1 (2) powered by cb 1 (cb 2) INST PWR CONT (pnl 276).

(2) System can be pressurized to normal reg press if He press is >600 psi.

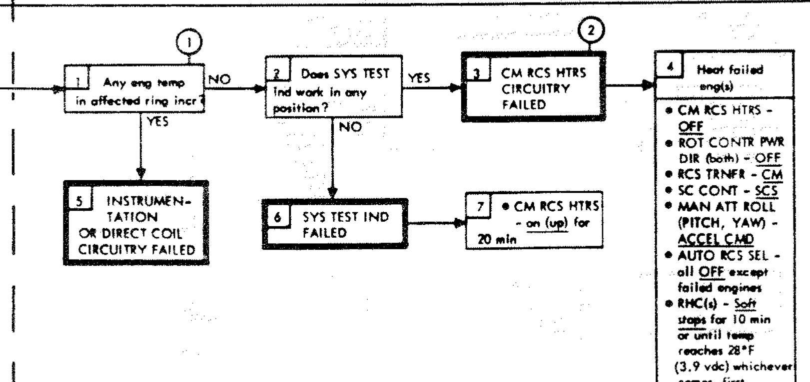
(3) Degraded sys usable if necessary. Leakage may be He or prplnt. Prplnt leakage into CM area is not aggravated by use of CM RCS engs.

(4) As a last resort, the He systems can be interconnected by placing the CM RCS LOGIC - on (up) then the CM PRPLNT DUMP - on (up) momentarily, then OFF. Once interconnected, systems cannot be isolated and all He could be lost.

SYMPTOM

5 CM RCS ENG TEMP FAILS TO INCR

PROCEDURE



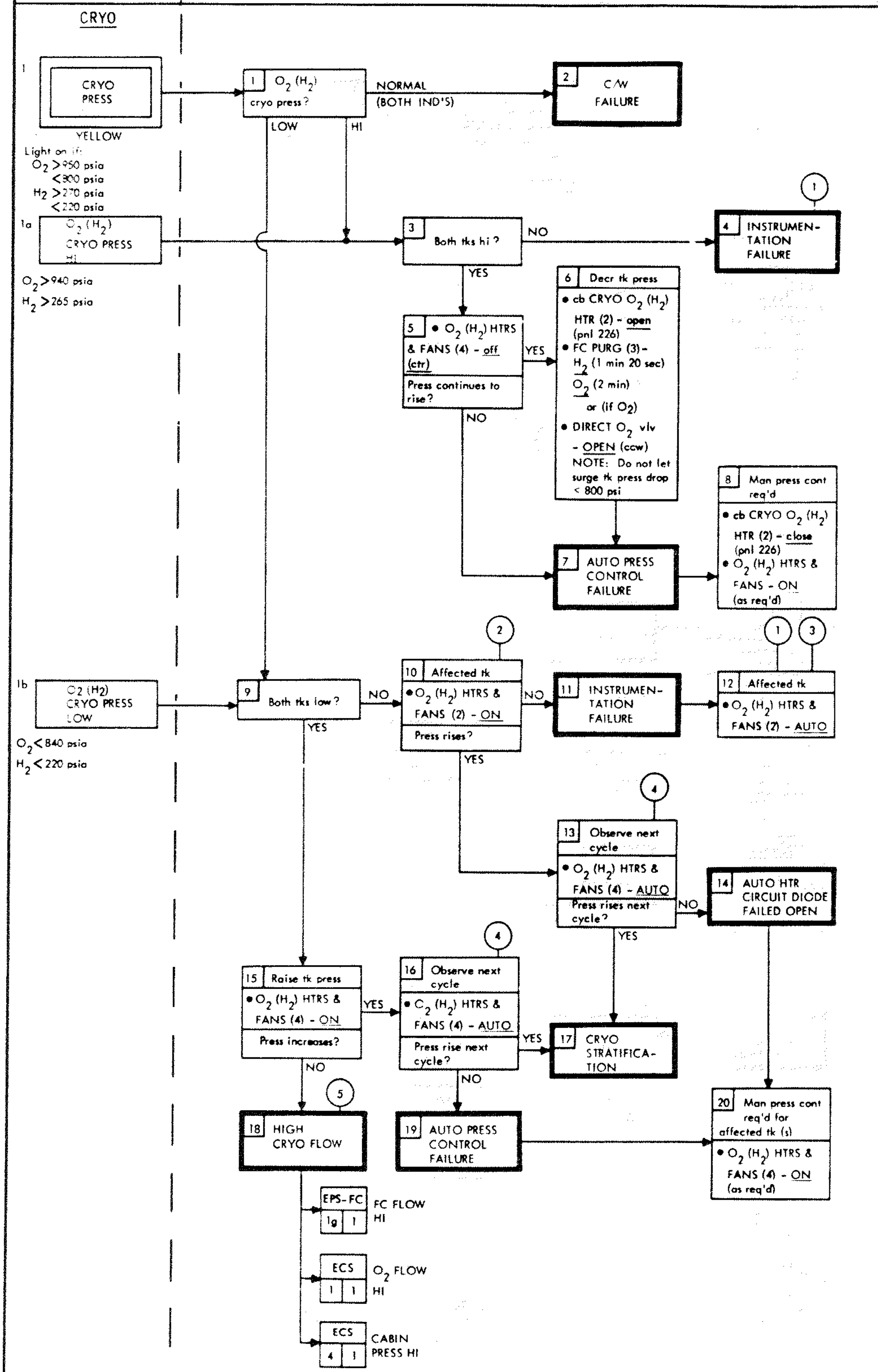
REMARKS

(1) Six RCS engs are instrumented. SYS TEST (2) in positions 6-A, B, C, D checks temp in engs 12, 14, 16 and 21. SYS TEST (2) in positions 5-C and D checks temp in engs 24 and 25.

(2) Htrs sw failure can be verified by observing DC AMPS indicator for change during sw operation.

SM-2A-1939F

SYMPTOM | PROCEDURE | REMARKS



REMARKS

1. MSFN may have valid press signal. If O_2, a check of surge tk press will validate cryo tk press within high limits.

2. An immediate drop in press upon htr/fan operation is indicative of stratification. Allow sufficient time for press rise indication.

3. Use unaffected tk to estimate cryo press.

4. Observation of more than one cycle may be necessary.

5. Resultant flow rate will be detectable in other systems.

EPS MALFUNCTION

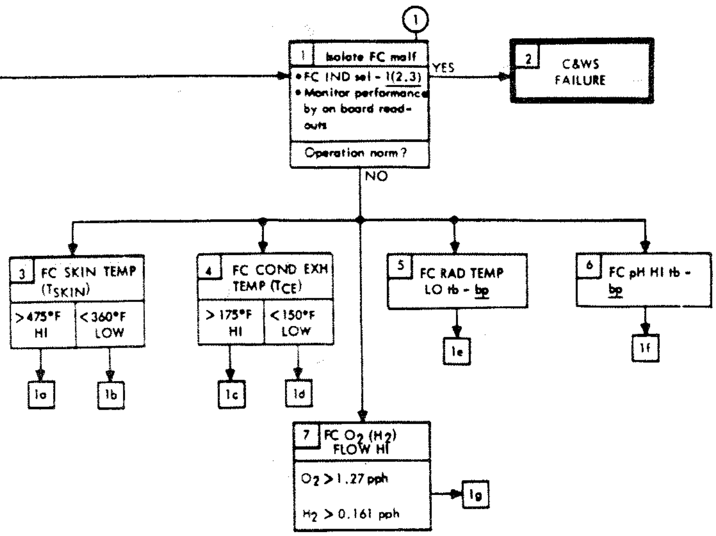
SYMPTOM	PROCEDURE	REMARKS

FUEL CELL

1 FC 1 (2,3)

YELLOW

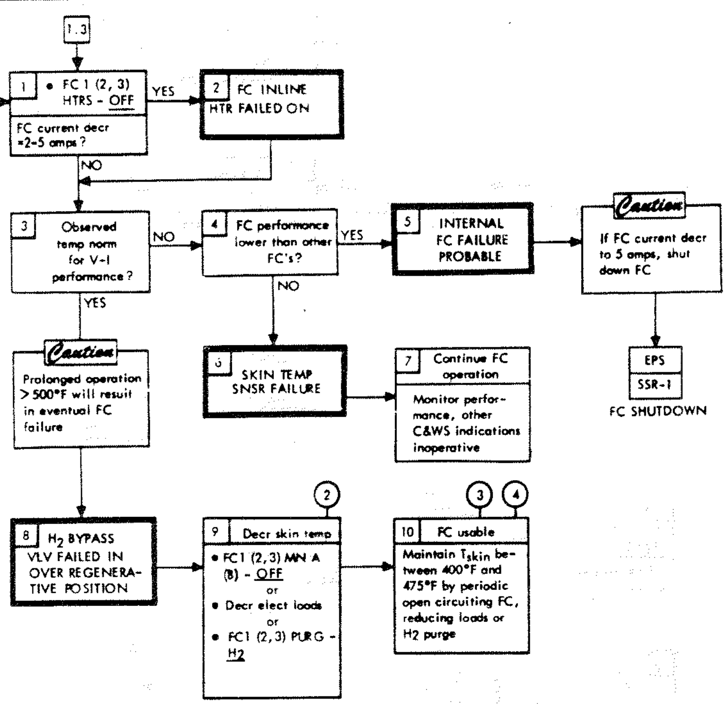
Light on if:
One or more of the six monitored functions exceeds its limits.



① FC pump cb's, O_2 and H_2 flow low, O_2 and H_2 reg out press. and sys performance are part of sys verification, but are not monitored by Caution and Warning sys.

1a FC 1 (2, 3) SKIN TEMP HI

> 450°F



① If T_{CE} also abnormal, enter appropriate T_{CE} procedure (1c or 1d).

② Purging H_2 will tend to reduce FC temp. H_2 purge flow is 0.7 pph.

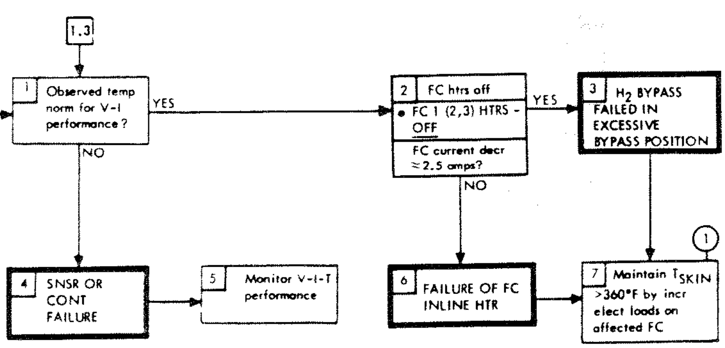
H_2 purge should be preceded whenever possible by ≈20 min of H_2 purge line htr operation. Criticality of operation above 500°F may preclude this operation.

③ Reactivate inline htr on open circuit F/C.

④ MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus.

1b FC 1 (2, 3) SKIN TEMP LOW

≤360°F

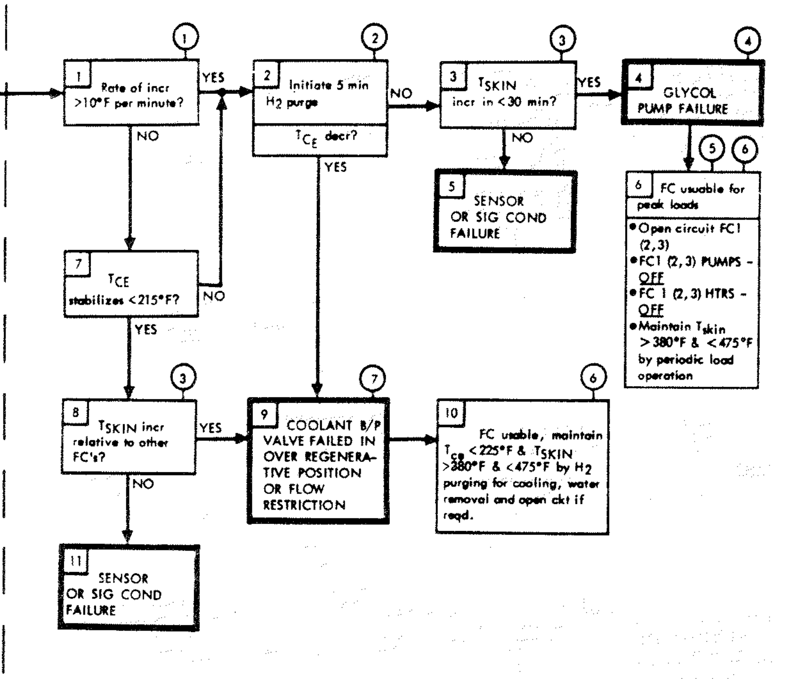


① If T_{SKIN} continues to decr, FC operation may continue until ≈330°F with degraded output.

SYMPTOM	PROCEDURE	REMARKS

FUEL CELL

1c FC1 (2,3) MOD COND EXH TEMP HI
>175°F



(1) Cyclic overheats to 250°F may be tolerated. Use H_2 purge to prevent steady state T_{ce} from exceeding 225°F at 25 amps.

(2) If possible, H_2 PURGE LINE HTR should be ON (up) 20 min prior to purge.

(3) FC load changes may affect rates of temperature change.

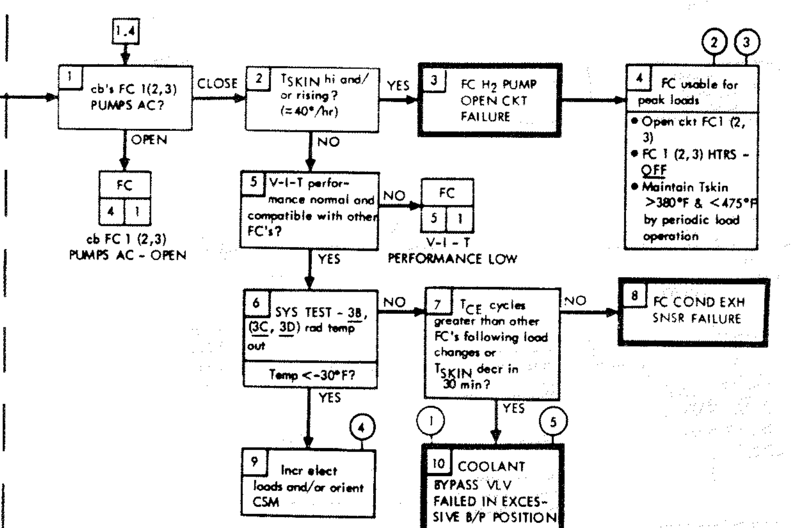
(4) If coolant pump failure is confirmed by MSFN reporting rad in and rad out temps converging, turn FC PUMPS - OFF for affected FC.

(5) Loss of glycol pump will result in loss of H_2 pump due to overheating. H_2 pump loss will result in in-line htr burn out if used.

(6) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus.

(7) MSFN can determine if reduced flow condition exists.

1d FC 1 (2, 3) COND EXH TEMP LOW
< 150°F



(1) Low T_{CE} is no restriction to FC operation if rad out and T_{SKIN} are maintained within limits.

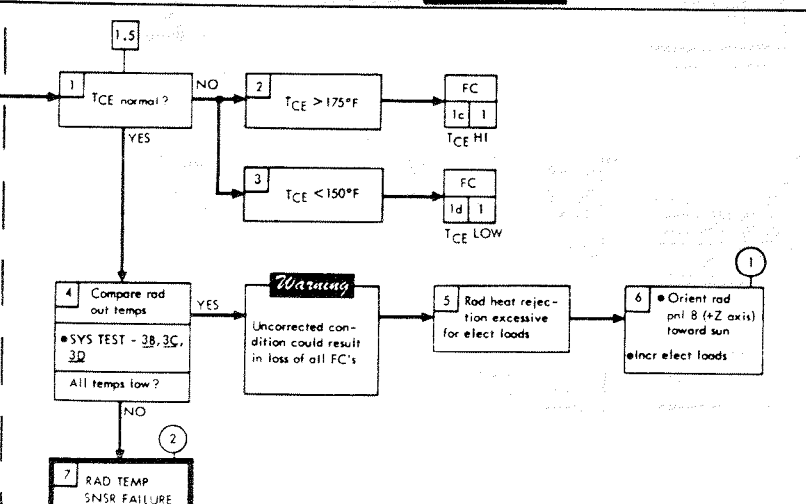
(2) If H_2 pump is not running, inline htr will burn out if used.

(3) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus

(3) Since continuous operation with rad out temp <-30°F may result in rad freezing or high pressure drop and pump stall, consideration may be given to rad bypass. However, this procedure may be an irreversible action.

(4) Performance may be improved due to electrolyte dehydration. Voltage should be maintained within limits.

1e FC 1 (2, 3) RAD TEMP LOW rb - bp
<-30°F



(1) Since continuous operation with rad out temp <-30°F may result in rad freezing or high pressure drop and pump stall, consideration may be given to rad bypass. However, this procedure may be an irreversible action.

(2) Use other FC rad out temp's for confirmation or MSFN can confirm snsr failure from FC rad inlet temp's.

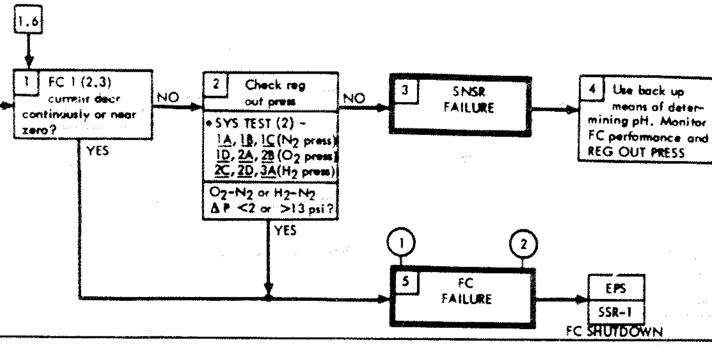
MALFUNCTION · EPS

SYMPTOM	PROCEDURE	REMARKS

FUEL CELL

1f

FC 1 (2, 3) pH HI tb - bp



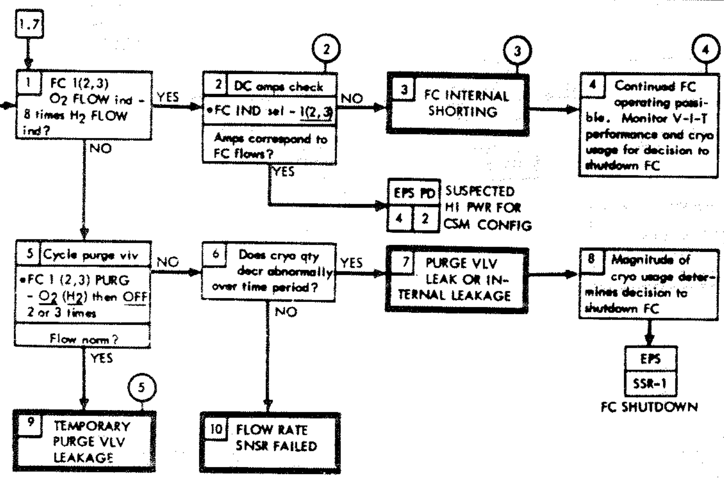
1 **Caution** Do not purge FC if flooding is suspected. Plugging of common vent line may result.

2 Isolate potable H_2O tk for 60 min to direct contaminated H_2O to waste tk.

1g

1 FC 1 (2, 3) O_2 (H_2) FLOW HI

O_2 > 0.8 pph
H_2 > 0.1 pph



1 H_2 purging will result and O_2 purging may result in FC C&WS alarm.

2 FC O_2 FLOW = $\frac{\text{amps} \times 2}{100}$

FC H_2 FLOW = $\frac{\text{amps} \times 2.5}{1000}$

3 An accurate magnitude of the internal short can be determined from the reactant flows when the FC is on open ckt.

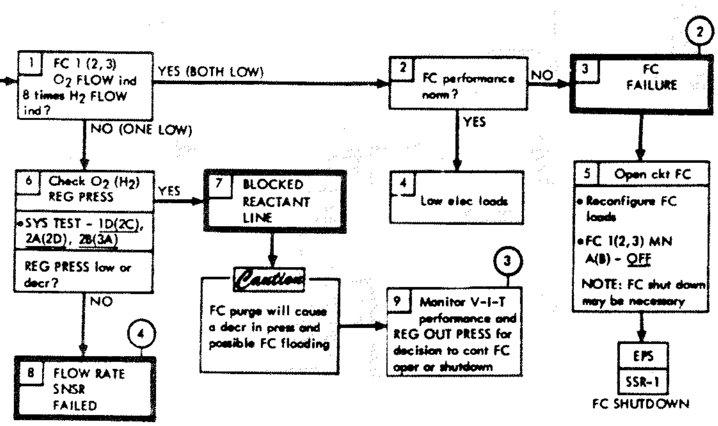
4 FC reactant conversion efficiency will continue to degrade with time.

5 Future purges may result in high flow.

2

1 FC 1 (2, 3) O_2 (H_2) FLOW LOW

O_2 < 0.3 pph
H_2 < 0.04 pph



1 FC flow and press instrumentation powered by INST PWR CONT cb's (pnl 276).

2 Flooding is most probable cause. Isolate potable tank to direct possible contaminated H_2O to waste tank until FC condition is positively determined.

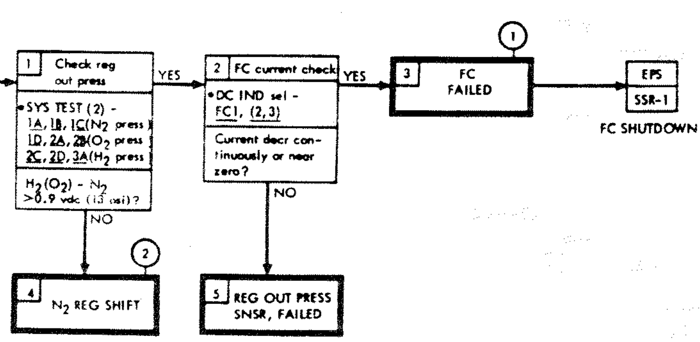
3 If reactant ΔP drops to less than 2 psi above N_2, shut down FC to avoid flooding.

4 Other reactant indicator may be used for affected flow indication.

3

FC REG O_2 (H_2) OUT PRESS HI

>70 psi



1 pH HI tb may indicate bp. If so, isolate potable H_2O tank for 60 min. to direct contaminated H_2O to waste tank.

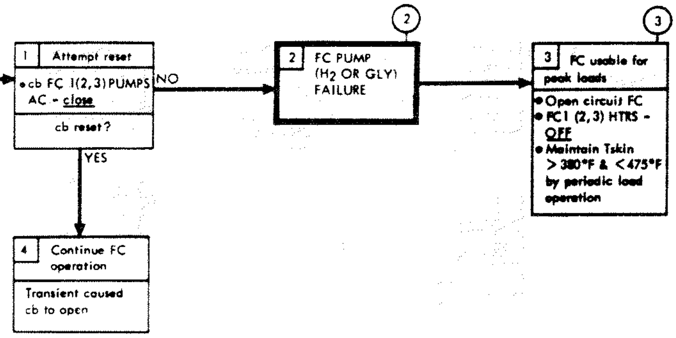
2 Failure of N_2 regulator will raise H_2, O_2, and N_2 press but not dangerously. FC should continue to operate at new press with slight performance change. Heat transfer will not be affected by incr in accumulator press.

SM-2A-1968B

SYMPTOM	PROCEDURE	REMARKS

FUEL CELL

4 cb FC 1 (2, 3) PUMPS AC - OPEN (1)



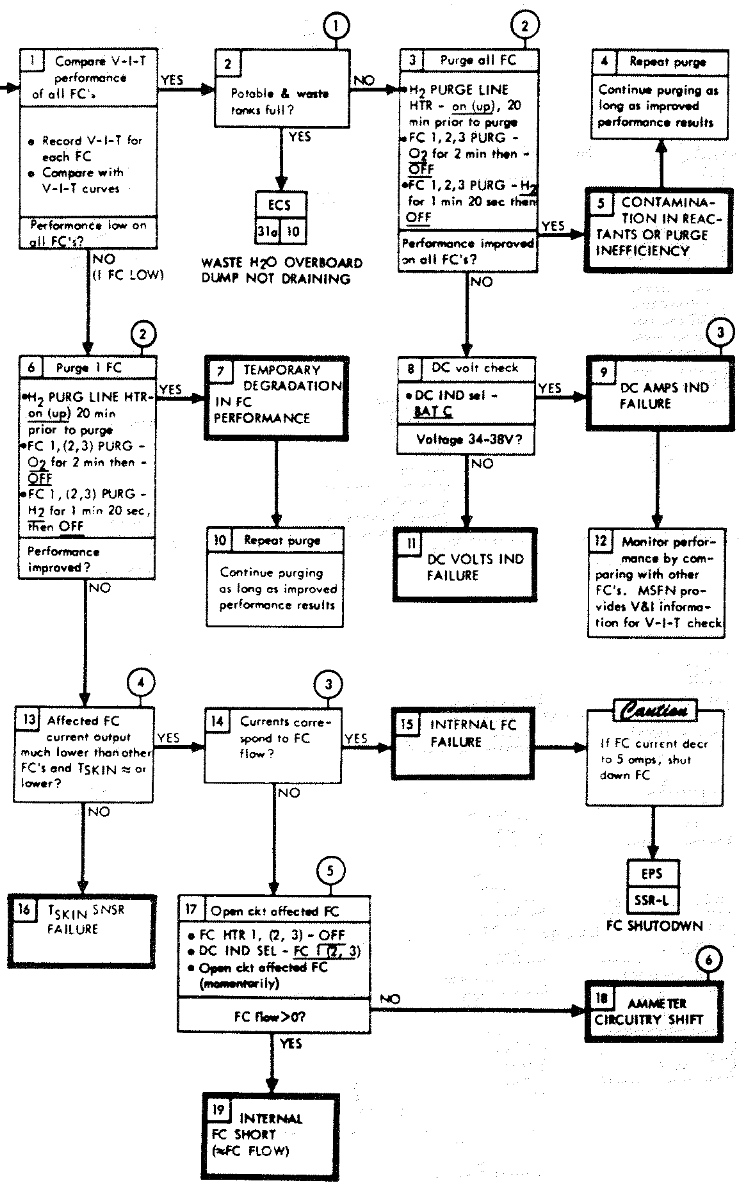
REMARKS:

(1) This condition will result in low T_{CE} and/or high T_{SKIN}.

(2) pH snsr lost since power is [illegible] to pumps.

(3) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus.

5 FC 1 (2, 3) V-I-T PERFORMANCE LOW



REMARKS:

(1) If both potable & waste H_2O tanks are full, possible freezing of waste H_2O dump line may be cause.

(2) Verify purge flow by incr in reactant flow.

(3) Ammeter accuracy can be verified by FC reactant flow

$$\text{FC } O_2 \text{ flow} = \frac{\text{amps} \times 2}{100}$$

$$\text{FC } H_2 \text{ flow} = \frac{\text{amps} \times 2.5}{1000}$$

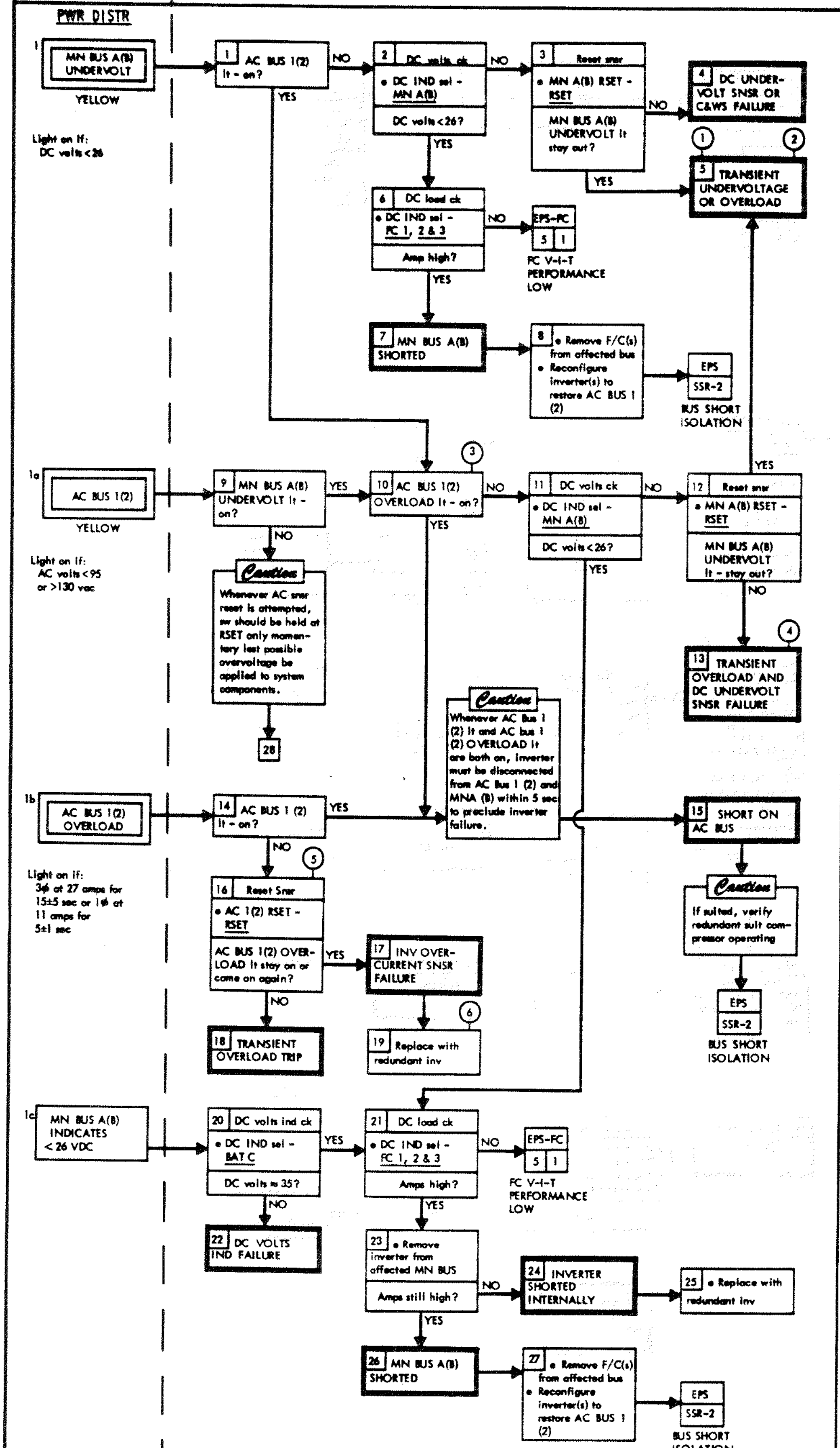
(4) If only 2 FC's are in operation, both FC's should be tied to both buses for this check. Time must be allowed for T_{SKIN} to stabilize.

(5) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus.

(6) Use reactant flow rates to estimate current.

SM-2A-1969D

SYMPTOM	PROCEDURE	REMARKS



REMARKS

1. Open cb's may result.
2. Reset AC sensor to extinguish AC BUS lt.
3. Light comes on when AC current exceeds 27 amps (3 phases) or 11 amps (single phase). AC BUS OVERLOAD lt may take from 4 to 20 sec to come on after AC BUS 1 (2) lt on.
4. Remote probability.
5. Placing AC BUS 1 or 2 RSET sw to RSET and releasing insures a MASTER ALARM pb/lts - on.
6. Original inverter may be used but will not have OVERLOAD warning. AC bus 1 (2) should be reset to provide overvoltage protection.

SYMPTOM	PROCEDURE	REMARKS

PWR DISTR

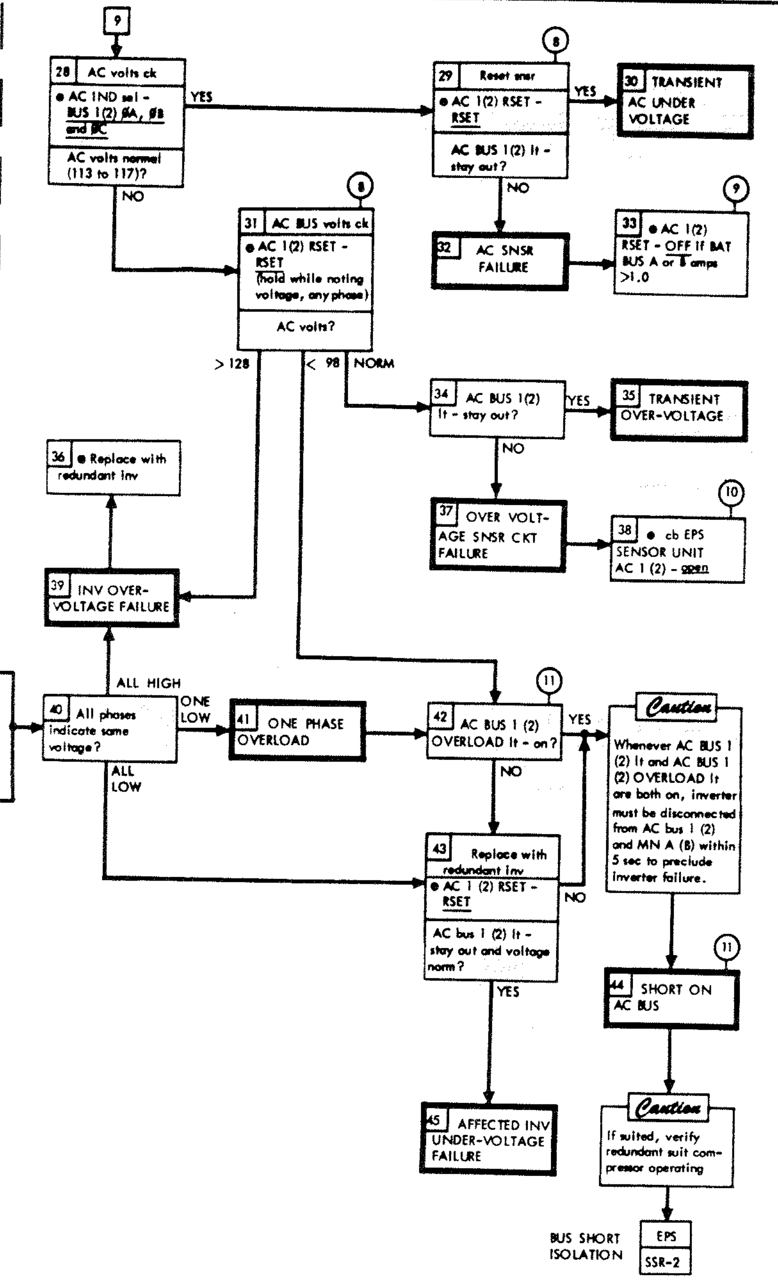
1c cont

1d AC BUS 1 (2) VOLTAGE LOW

< 113 vac

1e AC BUS 1(2) VOLTAGE HIGH

> 117 vac



8 Placing AC BUS 1 or 2 RSET sw to RSET and releasing insures a MASTER ALARM pb/lts - on.

9 Subsequent auto inv disconnect for overvoltage lost. If sw left ON, overload indication available but overvoltage may not provide auto inverter disconnect.

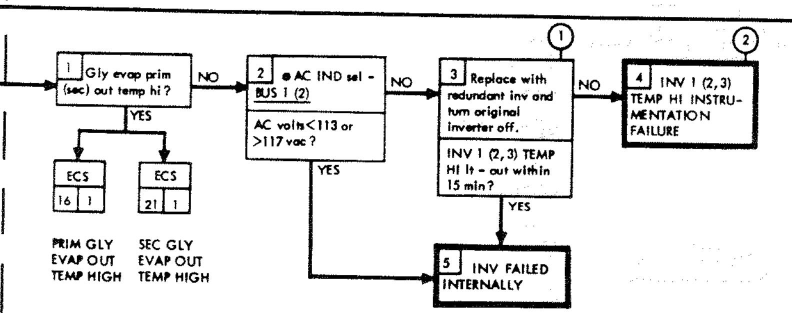
10 Subsequent auto inv disconnect for overvoltage and undervoltage indication lost. Overload indication unaffected.

11 AC BUS OVERLOAD lt may take from 4 to 20 sec to come on after AC BUS 1 (2) lt on. Light comes on when AC current exceeds 27 amps (3 phase) or 11 amps (single phase).

2 INV 1 (2,3) TEMP HI

YELLOW

Light on if:
Temp >190±3°F



1 Refer to checklist for inverter changeover.

2 Inv usable but no high temp indication available.

EPS MALFUNCTION

SYMPTOM	PROCEDURE	REMARKS

PWR DISTR

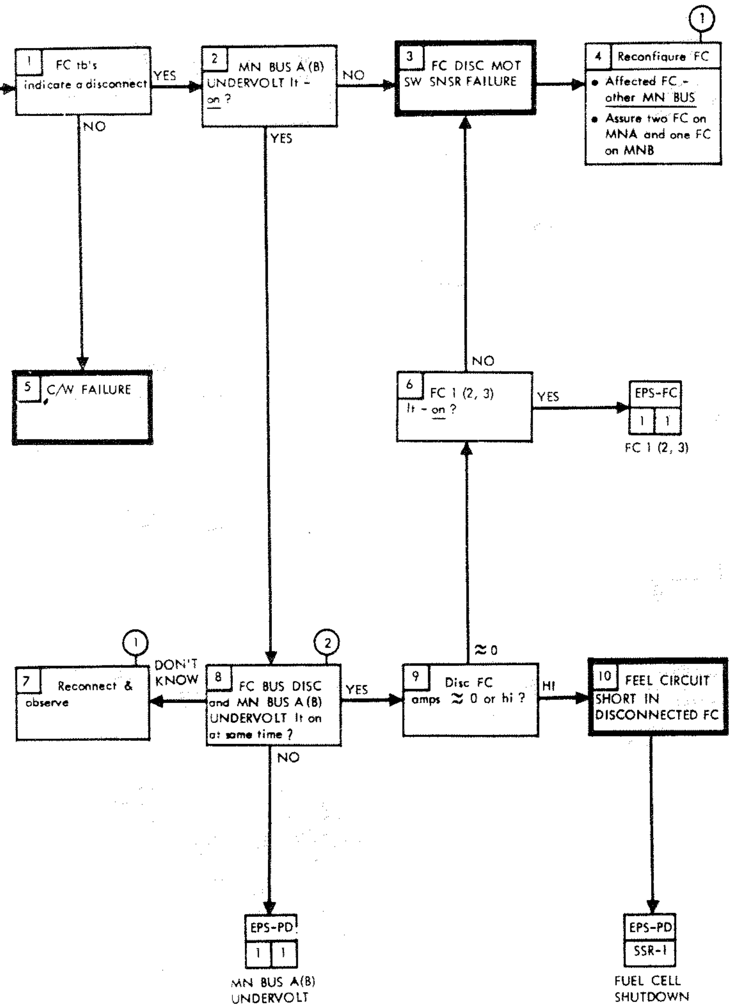
SYMPTOM

3 FC BUS DISCONNECT

YELLOW

Light - on
Overload >75 amp
Rev current >4 amp
(Assumes FC 1, 2 - MNA and FC 3 - MNB)

PROCEDURE



REMARKS

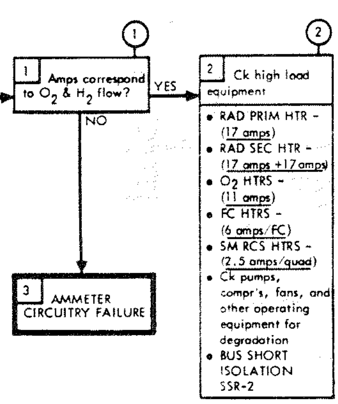
1 MASTER ALARM and FC BUS DISC lts will come on when reconnecting open- circuited FC to bus.

2 During actual overloads, the MN BUS UNDERVOLT lt may be on as long as 20 sec before the FC BUS DISC lt.

SYMPTOM

4 SUSPECTED HI CURRENT FOR CSM CONFIG

PROCEDURE



REMARKS

1 O_2 FLOW $\approx \frac{\text{amps} \times 2}{100}$

H_2 FLOW $\approx \frac{\text{amps} \times 2.5}{1000}$

2 a. ECS rad htrs operate:

RAD PRIM OUT TEMP <-15°F

RAD SEC OUT TEMP <+45°F

b. Cryo htrs & fans operate:

O_2 < 865 psia

H_2 < 225 psia

c. FC htrs operate:

T_{SKIN} < 380°F

d. SM RCS htrs operate at pkg temp:

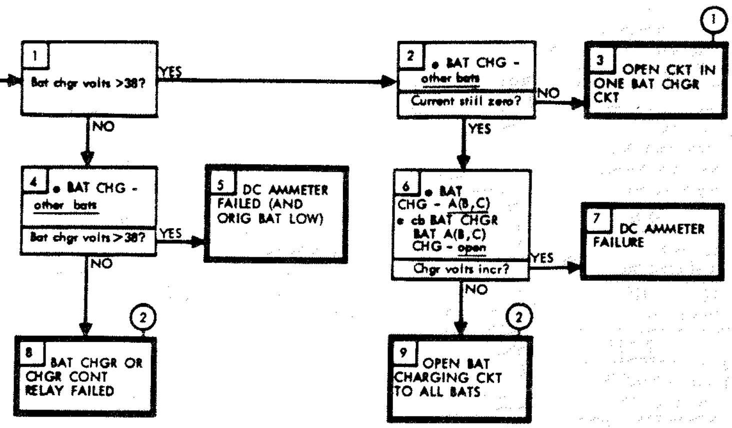
PRIM < 115°F

SEC < 115°F

SYMPTOM	PROCEDURE	REMARKS

PWR DISTR

5 BAT CHGR CURRENT ZERO

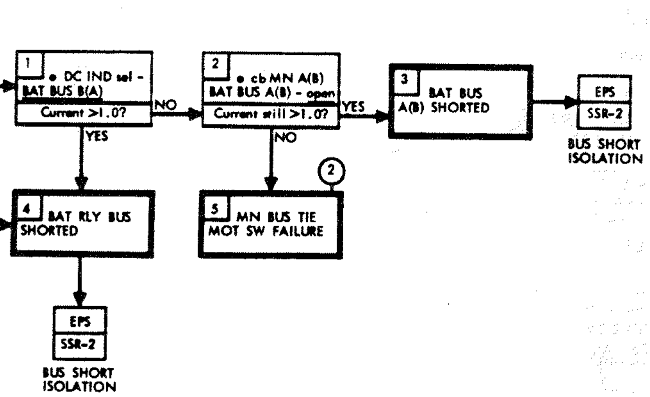


(1) Affected battery might still be charged throught BAT TIE cb's

(2) Battery charging capability lost.

6 BAT BUS A(B) CURRENT >1.0 WITH MN BUS TIE (2) - OFF (1)

6a FC tb's ALL GRAY (3)



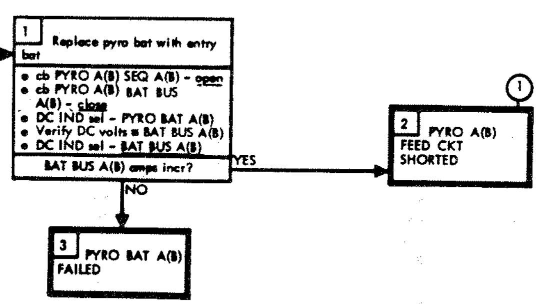
(1) Bat bus current will be <1.0 amps for all mission phases except:

a. Prelaunch (<3.0 amps)
b. Boost & insertion
c. ΔV maneuvers
d. Deorbit & entry.

(2) If a, b & c batts on MN buses, cycling MN bus tie switches may correct the problem. If not, MN bus tie will have to be accomplished by cb action. May have to change battery through other battery bus.

(3) Not valid after CM/SM separation.

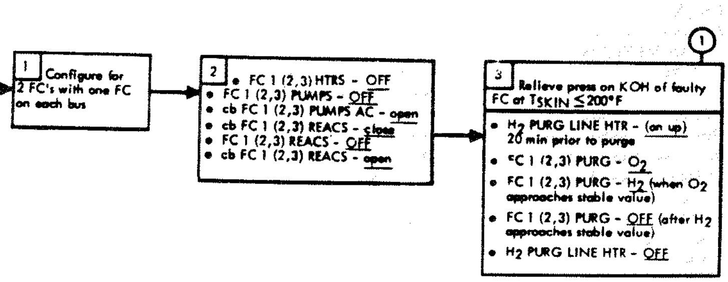
7 PYRO BAT VOLTAGE <35 VDC



(1) It is crew option to leave a main battery connected to a known short to retain redundant pyro circuit capability. If dc amps >30, expect cb PYRO A(B) BAT BUS A(B) to open within 1 to 5 min and loss of redundant pyro circuit.

SPECIAL SUB ROUTINE

SSR-1 FUEL CELL SHUTDOWN



(1) FC will not reach T_{SKIN} = 200°F for approximately 24 hours.

KOH will be solidified at $T_{SKIN} \leq 200°F$. The press is relieved to reduce the possibility of corrosive fluid leaking into the SM and to insure sealing of the check vlv, isolating the potable water from the FC.

SYMPTOM	PROCEDURE	REMARKS

SSR-2

BUS SHORT ISOLATION

1 Remove all equipment from affected bus

2 Affected bus?

- MNA (B) → 16
- AC 1 (2) → Caution
- BAT A (B) → 22
- BAT RLY BUS → 3

Caution

Whenever AC BUS 1(2) lt and AC BUS 1(2) OVERLOAD lt are both on, inverter must be disconnected from AC BUS 1(2) AND MNA(B) within 5 sec to preclude inverter failure.

3 Bat chgr to bat bus

- cb ENTRY/PL BAT A - open (pnl 250)
- cb BAT RLY BUS BAT B - open
- BAT CHG - A
- DC IND sel - BAT CHGR

Bat chgr amps > 0?

NO → 6; YES → 8 (1)

4 Individually close equip cb's or sws while monitoring FC current

5
- INV 1(2) - to affected bus

AC BUS 1(2) OVERLOAD lt on?

NO → 4; YES → 7

6 Return to original configuration. Close cb's to isolate affected equip.

7 AFFECTED AC BUS LOST

AC1 → 9; AC2 → 10

8 Current drain on BAT RLY BUS. Bus loss depends on magnitude of current drain

9 AC1 BUS reconfiguration

- INV 1 - OFF
- INV 1 AC1 - OFF
- SUIT COMPR - AC2
- FDAI SEL - 2
- BMAG MODE (3) - RATE 2
- S BD PWR AMPL PRIM - SEC
- S BD XPNDR - SEC
- FC 1 PUMP - AC2
- GLY PUMPS - 2 AC2
- BMAG 1 PWR - OFF
- G/N PWR - AC2
- SIG CONDR/DR BIAS PWR 1 - AC2
- Maintain GLY EVAP TEMP INLET temp > 40°F
- RAD FLOW CONT AUTO - 2
- BAT CHGR - AC2

10 AC2 BUS reconfiguration

- INV 2 - OFF
- INV 2 AC2 - OFF
- ELEC PWR - ECA
- Verify OMNI in proper configuration for MSFN
- FC 2 & 3 PUMPS - AC1
- BMAG 2 PWR - OFF
- FDAI SEL - 1
- SIG CONDR/DR BIAS PWR 2 - AC1
- BMAG MODE (3) - RATE 1
- Activate SEC COOL LOOP
- Shut down PRIM EVAP

11 Isolate BAT RLY BUS from BAT A & B

- cb BAT RLY BUS BAT A - open
- cb BAT RLY BUS BAT B - open
- Return BAT RLY BUS load to original config

12 BAT RLY BUS non-transferable loads

EPS/CRYO
- FC reacs vlvs, latch ckt & tb's
- FC rad bypass vlvs & tb's
- FC to bus cont & tb's
- DC undervolt sensing if CW NORM - ACK
- AC over/undervolt sensing & CW lt
- AC ovld CW lt (if CW NORM - ACK)
- Inverter cont (DC & AC)

13 AC1 BUS non-transferable loads

EPS/CRYO
- Tank 1 H_2 & O_2 fans
- Tank 1 H_2 & O_2 qty & temp sig condr (ØC)

ECS
- Cabin fan 1
- Man cont prim evap stm vlv (ØC)
- Auto cont prim gly cont vlv (ØA)
- Sec loop evap cooling (ØA)
- Elect cont suit heat exch gly bypass vlv (ØB)
- Red flow contr 1 & rad isol vlvs (ØC)

SCS
- GDC (all modes except RSI)
- FDAI 1
- BMAG 1 (ATT HOLD, RATE CMD)
- Min Imp (ØA)
- RHC 1 MTVC (ØA)
- Rate cmd prop att cont (ØA)
- Auto ΔV (ØA)
- No 1 pitch & yaw needles on GPI (ØA)
- SII fuel & SIVB fuel & oxid press for ind No 1 (ØA)

LIGHTING
- FDAI 1
- EMS numerics & grid
- Mission timer numerics (pnl 2)
- DSKY numerics (pnl 2)
- EL for pnls 1 thru 9, 15, 16, 229, 275
- Sys 1 SM running lts (8 elements) & EVA lt (1 element)

14 AC2 BUS non-transferable loads

EPS/CRYO
- Tank 2 H_2 & O_2 fans
- Tank 2 H_2 & O_2 qty & temp sig condr (ØC)
- AC utility outlet (pnl 201)

ECS
- Cabin fan 2
- Prim evap temp cont unit (ØA)
- Auto cabin temp cont unit ØC
- Rad flow contr 2 & isol vlvs(ØC)

SCS
- MTVC (RATE CMD, ACCEL CMD)
- Prop rate cmd (TVC, ATT CONT)
- FDAI 2
- BMAG 2
- RSI (ØA)
- GDC (ØA)
- Auto ΔV (TVC) (ØA)
- Ordeal
- No 2 pitch & yaw needles on GPI (ØA)
- SII fuel & SIVB fuel & oxid press for indicator No 2 (ØA)

LIGHTING
- EMS roll att & scroll lts
- Mission timer numerics (pnl 306)
- DSKY numerics (pnl 140)
- EL for pnls 10, 100, 101, 122, 226, 306
- Sys 2 CM running lts (8 elements) & EVA lt (1 element)
- Docking target & spot lt

REMARKS

(1) If short circuit amps < 2.0, it is a crew option to maintain bat relay bus powered to retain AC bus sensors and FC overcurrent/reverse current protection functions. Increased battery recharge cycle may be required. If short circuit > 2.0 amps, close bat relay bat A or bat B cb's only when required to operate equipment connected to bat relay bus.

SM-2A-2248

SYMPTOM	PROCEDURE	REMARKS
		(2) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus. (3) Place two batteries on remaining bus for SPS maneuvers.

2 → (2)

16 ● DC IND sel - FC 1 (3)
● FC 1 (3) MN BUS A (B) - on (momentarily)
DC amps >25?

NO → **15** Individually close equip cb's or sws while monitoring FC current

YES → (3) **17** AFFECTED MAIN DC BUS LOST

MNA → 18; MNB → 19

18 MN BUS A reconfiguration

- FC 2, 3 - MNB only
- FC 1 MNB - on (up) (if reqd)
- FC 1 MNA - OFF
- INV 1 AC1 - OFF
- INV 1 - OFF
- INV 3 - MNB
- INV 3 AC1 - on (up)
- cb MNA BAT BUS A - open
- cb MNB BAT C - close
- SUIT H_2O ACCUM AUTO - 2
- BMAG MODE (3) - RATE 2
- FDAI SEL - 2
- URINE DUMP - HTR B
- WASTE H_2O DUMP - HTR B
- RHC PWR DIR 2 - MNB
- AUTO RCS SEL (16) - MNB (as reqd)
- RAD PRIM HTR - 1
- RAD FLOW CONT AUTO - 2
- SPS LINE HTRS - A/B (as reqd)
- SCS TVC (2) - RATE CMD
- Use RHC's for RCS dump, not CM PRPLNT DUMP sw

19 MN BUS B reconfiguration

- FC 1, 2 - MNA only
- FC 3 MNA - on (up) (if reqd)
- FC 3 MNB - OFF
- INV 2 AC2 - OFF
- INV 2 - OFF
- INV 3 - MNA
- INV 3 AC2 - on (up)
- cb MNB BAT BUS B - open
- cb MNA BAT C - close
- BMAG MODE (3) - RATE 1
- RHC PWR DIR 1 - MNA
- AUTO RCS SEL (16) - MNA (as reqd)
- ELEC PWR - ECA
- RAD PRIM HTR - 2
- RAD FLOW CONT AUTO - 1
- Use RHC's for RCS dump, not CM PRPLNT DUMP sw

18 → 20; 19 → 21

20 MN BUS A non-transferable loads

EPS/CRYO
- Tank 1 H_2 & O_2 htrs
- Inverter 1 pwr
- Utility outlets (pnl 15 & 16)
- Tank 1 O_2 vac-ion pump

ECS
- CO_2 PP ind, CW lt & PSM
- Prim 2 rad htr cont
- Rad flow contr 1 & auto select
- Rad isol vlv man sel
- H_2O accum 1 auto & man cont
- Urine & waste H_2O dump htr A
- Steam duct htr A
- Sec rad htr cont
- Sec rad in & out temp ind & PCM

RCS
- CM sys 1 htrs
- CM sys 1 fuel & oxid purge
- CM oxid interconnect
- CM fuel/He interconnect
- CM sys 1 prplnt dump (42 sec TD)
- CM sys 1 prplnt isol vlv & tb
- SM B & D He 1 & 2 isol vlv & tb
- SM B & D prim/sec prplnt isol vlv & tb
- SM B & D sec fuel press isol vlv
- SM B & D htrs
- Transfer mot sw 1

SPS
- Pitch & yaw (prim) gmbl mots
- Enable pwr sol driver 1
- He vlv 1 & tb
- Pilot vlv 1 & 2
- Prim pilot pre-vlv
- Line htrs A
- PUGS test

SCS
- FDAI 1 total attitude
- GDC (except RSI)
- BMAG 1 htr & CW temp lt (eventually lose BMAG 1 as temp decreases)
- Auto coils CM RCS 1 (if prior to CM/SM sep)
- Direct ullage yaw D3 & B4
- Auto ΔV
- Auto attitude hold
- Rate 1 MTVC
- RHC pwr dir 1
  - a. MNA/MNB to half of jets
  - b. MNA to all jets
- RHC pwr dir 2, MNA/MNB to half of jets

LIGHTING
- RH girth shelf flood (fixed mode)
- RH couch flood (fixed mode)
- LH girth shelf flood (variable mode)
- LH couch flood (variable mode)
- LH & RH strut flood (variable mode)
- LH optical align sight
- Rendeavous lt
- Sys A tunnel lts (6 elements)

DISPLAYS & CONTROLS
- Mission elapsed timer (pnl 2)

DOCKING
- Sys A probe connector (however A & B connectors may be switched)

21 MN BUS B non-transferable loads

EPS/CRYO
- Tank 2 H_2 & O_2 htrs
- Inverter 2 pwr
- Utility outlet (pnl 100)
- LM power
- Tank 2 O_2 vac-ion pump

ECS
- O_2 high flow CW lt
- Prim 1 rad htr cont
- Rad flow contr 2
- Prim rad in temp ind & PCM
- H_2O accum 2 auto & man cont
- Urine & waste dump htr B
- Steam duct htr B

RCS
- CM sys 2 htrs
- CM sys 2 fuel & oxid purge
- CM fuel interconnect
- CM oxid/He interconnect
- CM sys 2 prplnt dump (42 sec TD)
- CM sys 2 prplnt isol vlv & tb
- SM A & C He 1 & 2 isol vlv & tb
- SM A & C prim/sec prplnt isol vlv & tb
- SM A & C sec fuel press isol vlv
- SM A & C htrs
- Transfer mot sw 2

SPS
- Pitch & yaw (sec) gmbl motrs
- Enable pwr sol driver 2
- He vlv 2 & tb
- Pilot vlvs (3 & 4)
- Line htrs B
- Sec pilot pre-vlv

SCS
- FDAI 2 total attitude
- GDC
- BMAG 2 htr & CW temp lt (eventually lose BMAG 2 as temp decreases)
- Auto coils CM RCS 2 (if prior to CM/SM sep)
- Direct ullage pitch C3 & A4
- Auto ΔV (maybe degraded)
- Min imp increased to $\approx$42 MS
- RSI
- Ordeal
- RHC pwr dir 1, MNA/MNB to half of jets
- RHC pwr dir 2
  - a. MNA/MNB to half of jets
  - b. MNB to all jets

LIGHTING
- LH girth shelf flood (fixed mode)
- LH couch flood (fixed mode)
- LH & RH strut flood (fixed mode)
- RH couch flood (variable mode)
- RH girth shelf flood (variable mode)
- RH optical align sight
- Sys B tunnel lts (6 elements)
- Spotlight door initiator

DISPLAYS & CONTROLS
- Mission elapsed timer (pnl 306)

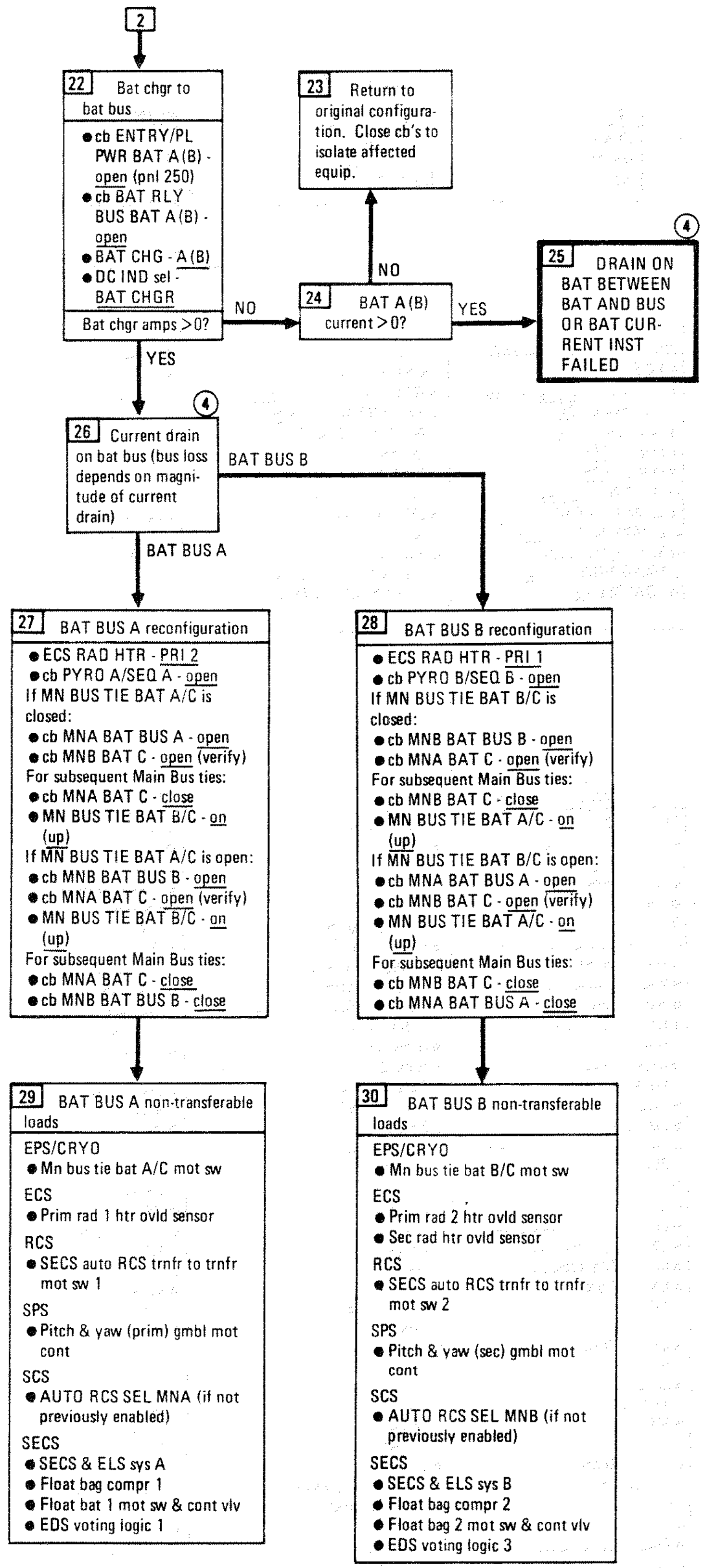
DOCKING
- Sys B probe connector (however A & B connectors may be switched)

EPS MALFUNCTION

SM-2A-2249

SYMPTOM	PROCEDURE	REMARKS

SSR-2 (CONT)



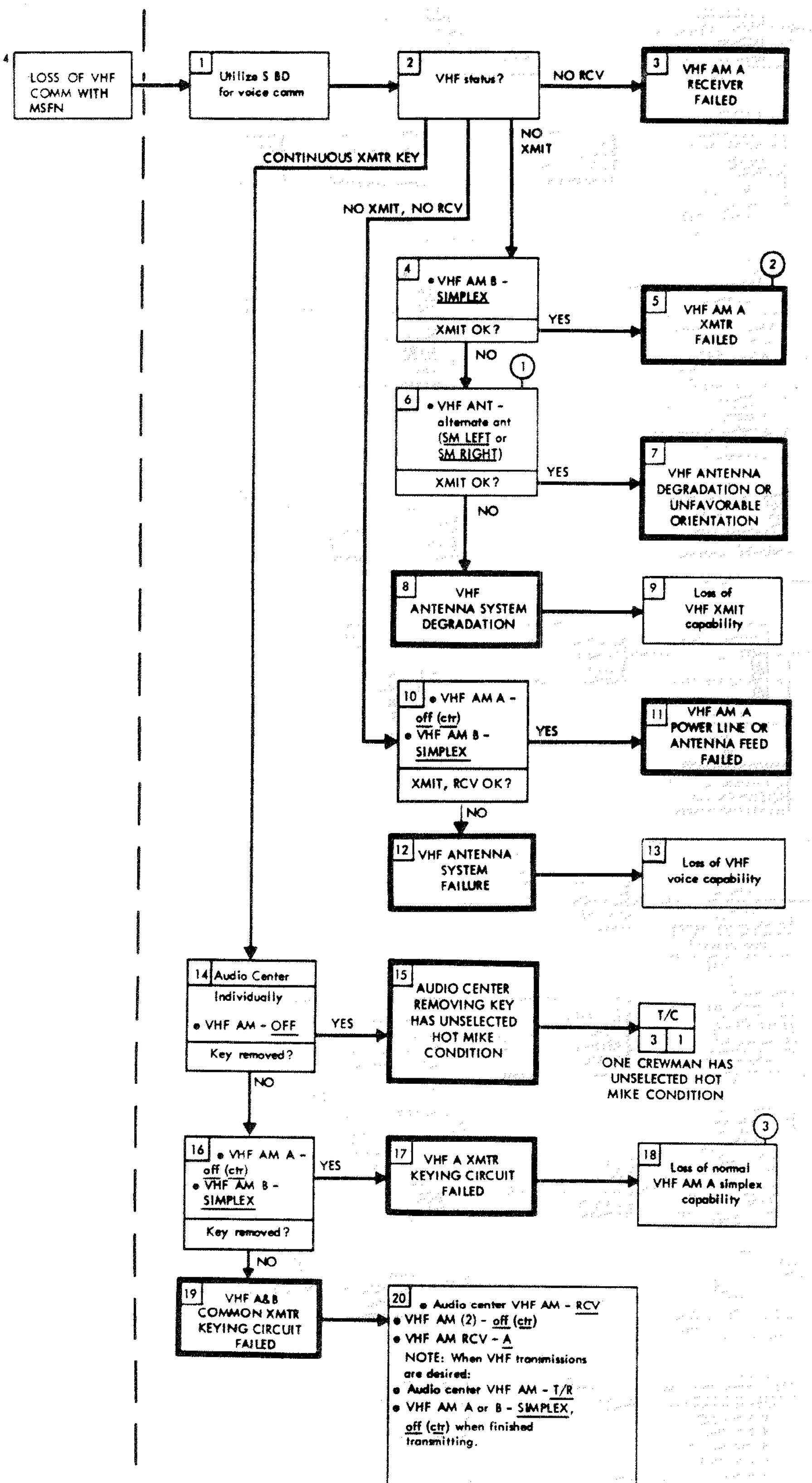
(4) If cb RAD HTRS OVLD BAT A and/or BAT B are opened to reduce battery drain, they should not be closed unless batteries are tied to main buses. This prevents possible disconnect of ECS radiator heaters by a false overload signal.

SM-2A-2250

SYMPTOM	PROCEDURE	REMARKS
1 ONE CREWMAN HAS NO INTERCOM CAPABILITY	1 Audio center (1) • MODE - alternate positions Intercom any mode? YES → 2; NO → 3 2 If failed mode is — INTERCOM/PTT → 4; PTT → 5; VOX → 6 3 Audio center • AUDIO CONT- BACKUP Intercom? NO → 7; YES → 8 4 MODE SWITCH CIRCUIT FAILED 5 PTT KEYING CIRCUIT FAILED 6 VOX KEYING CIRCUIT FAILED 7 Isolate failed components by substitution (2) Affected crewman's Audio Panel: • PWR - OFF • SUIT PWR - OFF • VHF AM - OFF • S BD MODE PCM - PCM or ctr • AUDIO CONT - NORM • Replace COMM components individually → 10 8 Backup intercom • PAD COMM (3) - T/R • AUDIO CONT - NORM Communication between crewmen returned? YES → 9; NO → 11 9 INTERCOM DIODE SWITCH FAILED (3) → 12 10 FAILURE OF REPLACED COMPONENT 11 AUDIO CENTER FAILED → 12 12 Use backup Audio center (4) • AUDIO CONT - BACKUP • PAD COMM (3) - OFF	(1) (CMP's audio center only) verify S BD MODE VOICE - not in RELAY. (2) Procedure removes all power from CCU. (3) No hot mike intercom available. S BD or VHF AM sidetone may be used as a backup intercom. Pad comm will be 10 times normal volume after liftoff. (4) Affected crewman's PTT switch is inoperative. In the event of intercom diode switch failure, transmissions to ground are available by returning AUDIO CONT - NORM.
2 LOSS OF INTERCOM (ALL CREWMEN)	1 Backup intercom • INTERCOM (3) - OFF • PAD COMM (3) - T/R Sidetone? NO → 2; YES → 4 2 FLIGHT & POST LANDING BUS FAILED (1) → 3 3 Select key mode (2) • UP TLM CMD - RSET then NORM • S BD MODE PCM - KEY • S BD MODE RNG - OFF 4 INTERCOM CIRCUIT FAILURE (3)	(1) Pwr lost to audio center equip and VHF AM. Capability to xmit and rcv voice via VHF AM, S BD or intercom is lost. Down voice substitute is CW. Up voice substitute is crew alert light. (2) Transmitted signal is not audible in this failure mode. (3) No hot mike intercom available. S BD or VHF AM sidetone may also be used as backup intercom.
3 ONE CREWMAN HAS UNSELECTED HOT MIKE CONDITION	1 Audio center • MODE - PTT • Talk without keying Hear yourself? NO → 2; YES → 4 2 VOX CIRCUIT FAILURE (1) → 3 3 Discontinue use of VOX mode 4 Audio center • VHF AM - OFF • Talk without keying Hear yourself? NO → 5; YES → 7 5 VHF A&B COMMON XMTR KEYING CIRCUIT FAILED → 6 6 • Audio center VHF AM - RCV • VHF AM (2) - off (ctr) • VHF AM RCV - A NOTE: When VHF transmissions are desired: • VHF AM A or B - SIMPLEX (off ctr to receive) 7 Audio center • VHF AM - T/R • S BD - OFF • Talk without keying Hear yourself? NO → 8; YES → 10 8 S BD ENABLING CIRCUIT SHORTED → 9 9 Audio center (2) (3) • AUDIO CONT - BACKUP • PWR - OFF 10 • S BD - T/R • Cycle PTT sw on RHC (left or center only) • Talk without keying Hear yourself? NO → 11; YES → 13 11 INTERMITTENT PTT SW ON ROTATION CONTROL → 12 12 Discontinue use of affected RHC PTT switch 13 Isolate failed components by substitution (4) Affected crewman's Audio Panel: • PWR - OFF • SUIT PWR - OFF • VHF AM - OFF • S BD MODE PCM - PCM or ctr • Replace COMM components individually • Talk without keying Hear yourself? NO → 14; YES → 15 14 FAILURE OF REPLACED COMPONENT 15 AUDIO CENTER OR ROTATION CONTROL PTT SWITCH FAILED (5) → 16 16 Audio center (3) • AUDIO CONT - BACKUP • PWR - OFF • VHF AM - OFF	(1) Results in A/G transmissions for all equipment selected to T/R. (2) Selecting the alternate audio center is necessary to avoid the HOT MIKE conditions and continuous S BD voice transmissions regardless of the position of the audio center S BD switch. (3) The PTT sw of affected crewman will be inoperative. (4) Procedure removes all power from CCU. (5) The audio center is still usable in the hot mike mode; undesired air-to-ground transmissions can be eliminated by placing the audio center S BD and VHF switches to OFF or RCV.

SM-2A-1958D

SYMPTOM	PROCEDURE	REMARKS



1 When operating with MSFN, uplink circuit margin is greater than down-link circuit margin. Antenna system degradation can therefore disable transmission while allowing reception.

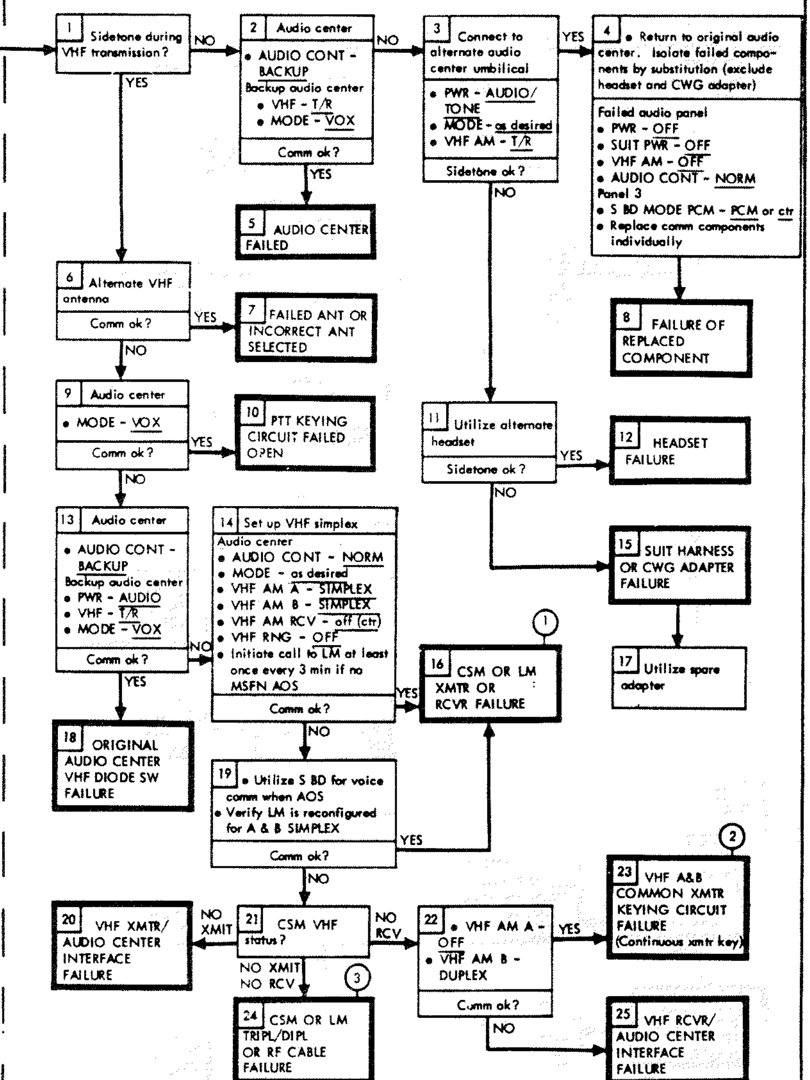
2 Duplex B is available.

3 Simplex operation of VHF AM A may be restored by placing VHF AM A - off (ctr) and VHF AM - T/R. Transmission is accomplished by placing VHF AM A - SIMPLEX then off (ctr) when finished transmitting.

SM-2A-1959E

SYMPTOM	PROCEDURE	REMARKS

5 LOSS OF VHF COMM WITH LM



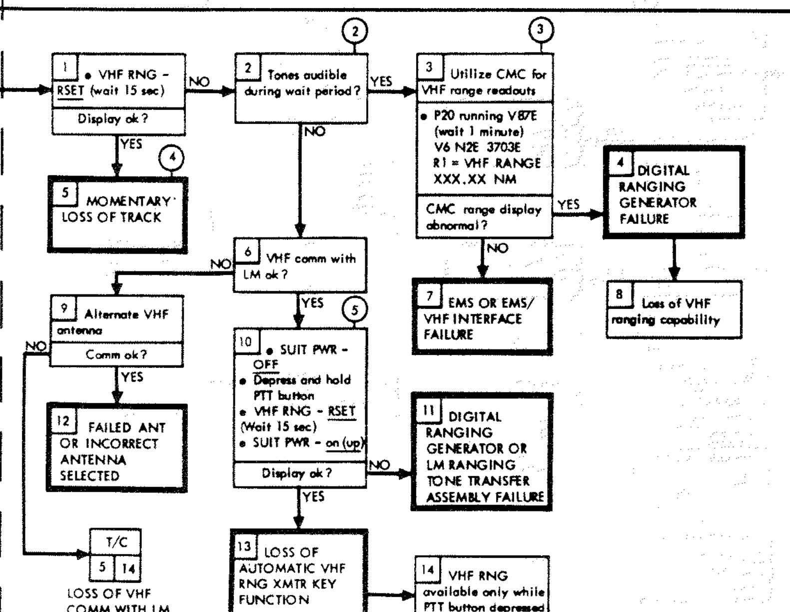
(1) Coordination between the two spacecraft can narrow the failure to a XMTR/RCVR combination. The specific combination depends upon which equipment was in use (i.e., whether LM data transfer or VHF ranging is in use).

Possible loss of VHF ranging and/or data transfer capability.

(2) VHF ranging still available.

(3) Loss of all VHF functions.

6 EMS RANGE DISPLAY ABNORMAL



(1) CMC TRACKER It should be on if computer is in P20 and V87 has been entered.

(2) Tones will be audible for 8 seconds after VHF reset. EMS display of range occurs 12 to 15 sec after reset.

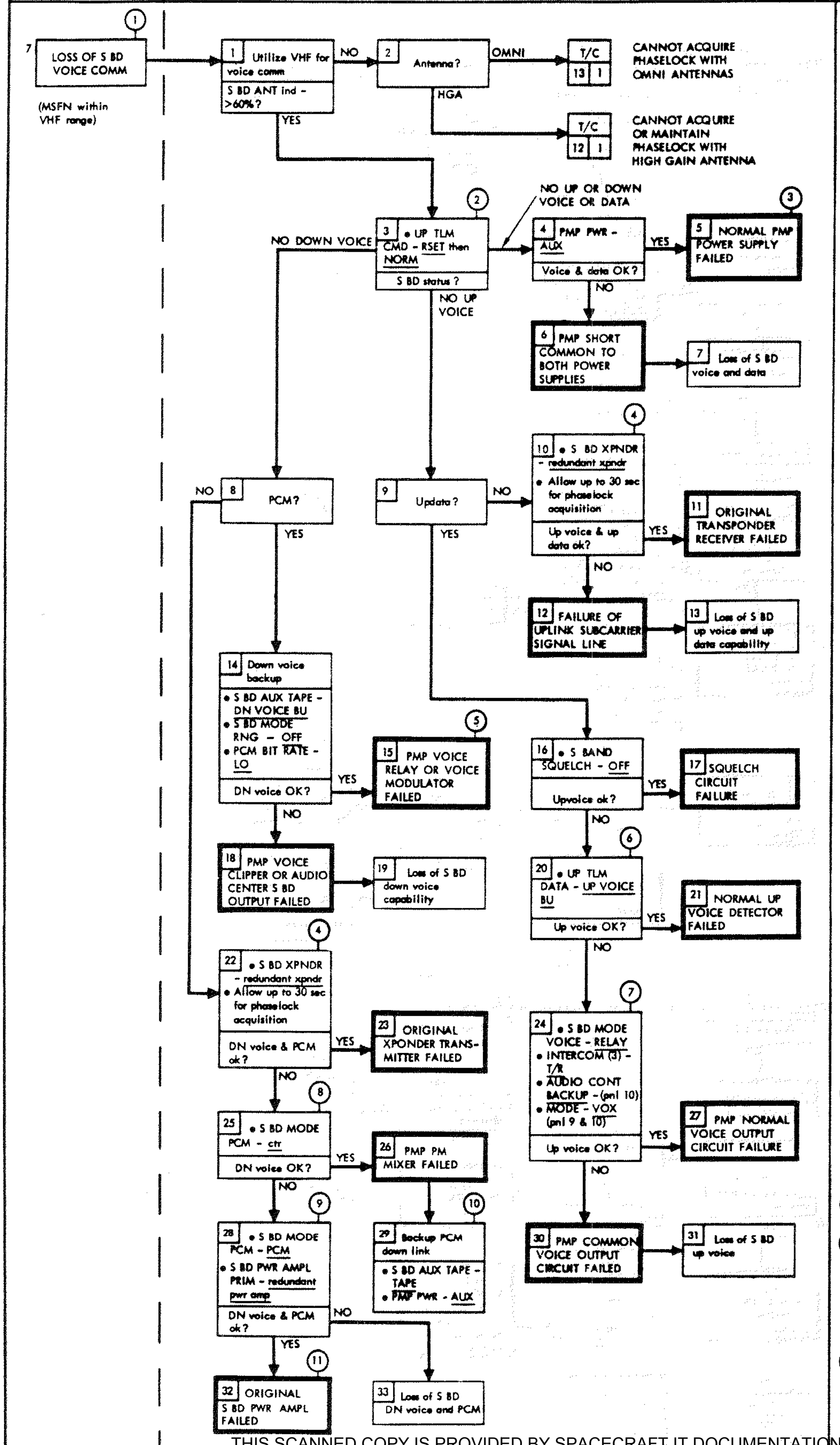
(3) If R1 is negative, actual range = 327.67 NM minus absolute value of R1. This will occur any time the range exceeds 163.83 NM.

(4) Temporary signal loss may be caused by antenna nulls or antenna switching.

(5) Turning suit power off precludes audio interference with VHF ranging initialization.

SM-2A-2048B

SYMPTOM	PROCEDURE	REMARKS



(1) Loss or near loss of upvoice is indicated by S BD ant ind <60% (approx), and noise in headset if S BD SQUELCH - OFF. Loss of normal downvoice should be anticipated if S BD ant ind 80% (approx).

(2) Notify MSFN of UP TLM reset action.

(3) The capability is lost to transmit recorded PCM.

(4) When S BD XPNDR - redundant xpndr, hesitate momentarily in OFF.

(5) Loss of capability of simultaneous transmission of down voice and HBR PCM.

(6) Notify MSFN to transmit voice on the up data subcarrier. Backup up voice and up data transmission must be time shared. Action will result in 1-2 KH_z tone in headset until MSFN configures for up voice backup.

(7) CMP PTT switch will be inoperative. S BD reception will be via Intercom bus.

(8) Provides an alternate voice circuit, but no PCM capability.

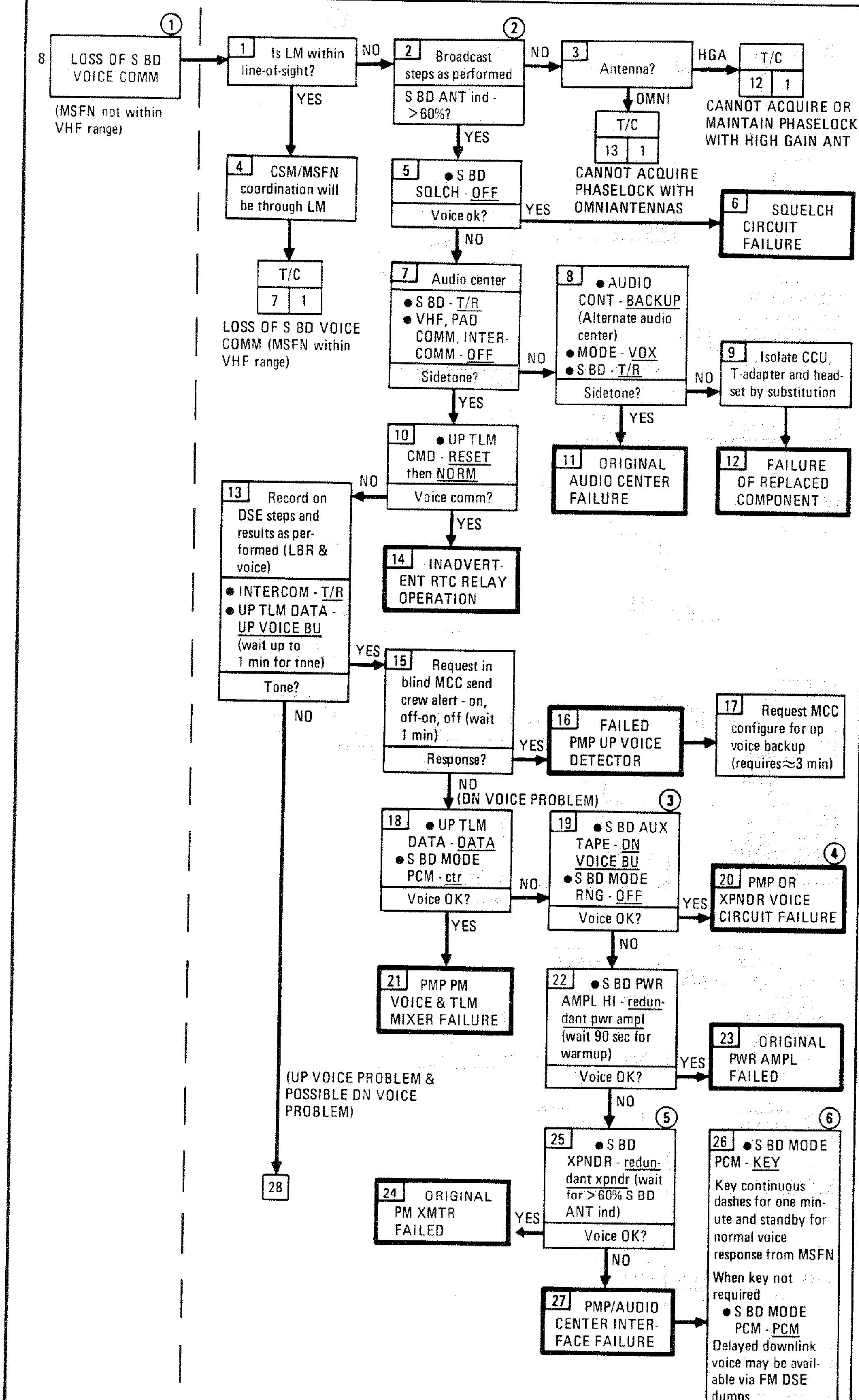
(9) The power amplifier requires a 90 sec warmup period.

(10) S BD AUX TAPE - TAPE activates the FM transmitter and the alternate power amplifier which requires a 90 sec warmup period. It is crew option to transmit real time PCM, recorded data, or TV via the FM transmitter.

(11) With one of the power amplifiers failed the capability is lost to transmit FM (recorded data or TV) simultaneously with PM transmission of real time PCM and voice.

SM-2A-1471H

SYMPTOM	PROCEDURE	REMARKS



REMARKS

(1) Due to numerous variables in lunar distance comm capabilities, this procedure attempts only to restore voice comm. Appropriate reconfiguration to restore maximum capability will be done real time based on nature of failure.

(2) Loss or near loss of up voice is indicated by S BD ant ind 60% (approx), and noise in headset if S BD SQUELCH-OFF. Loss of normal down voice should be anticipated if S BD and ind <80% (approx).

(3) If configuration is already DN VOICE BU, continue troubleshooting. Normal voice may be available on HGA or when MSFN range <130K NM.

(4) Normal down voice via relay and DUPLEX A (conference mode) may still be available.

(5) When S BD XPNDR - redundant xpndr, hesitate momentarily in OFF.

(6) INTERNATIONAL MORSE CODE

A • —
B — • • •
C — • — •
D — • •
E •
F • • — •
G — — •
H • • • •
I • •
J • — — —
K — • —
L • — • •
M — —
N — •
O — — —
P • — — •
Q — — • —
R • — •
S • • •
T —
U • • —
V • • • —
W • — —
X — • • —
Y — • — —
Z — — • •

1 • — — — —
2 • • — — —
3 • • • — —
4 • • • • —
5 • • • • •
6 — • • • •
7 — — • • •
8 — — — • •
9 — — — — •
0 — — — — —

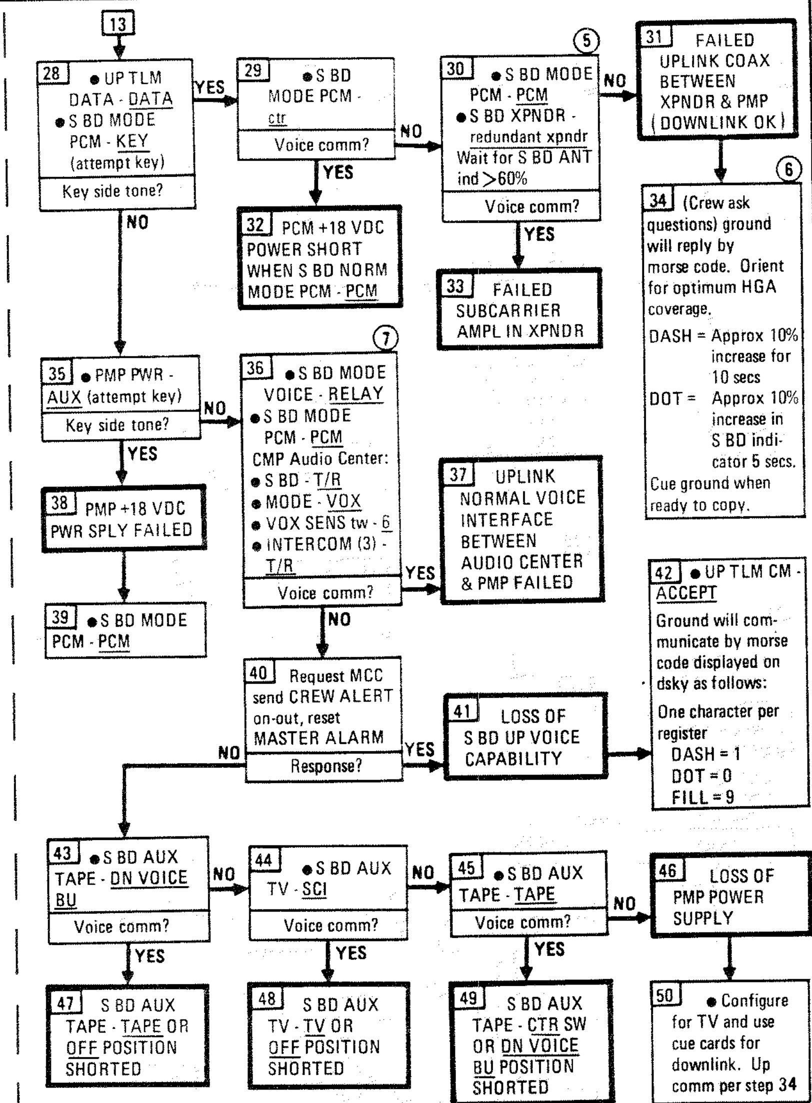
ERROR • • • • • • • •
WAIT • — • • •
END OF MESSAGE • — • — •
FRACTION BAR — • • — •
DOUBLE DASH — • • • —
INVITATION TO TRANSMIT — • —

SM-2A-2260

T/C MALFUNCTION

SYMPTOM	PROCEDURE	REMARKS

8 (Cont)



7 In relay mode for UP VOICE, CMP audio center DN VOICE not available. CMP select backup audio center. CDR and LMP use sidetone to copy up voice.

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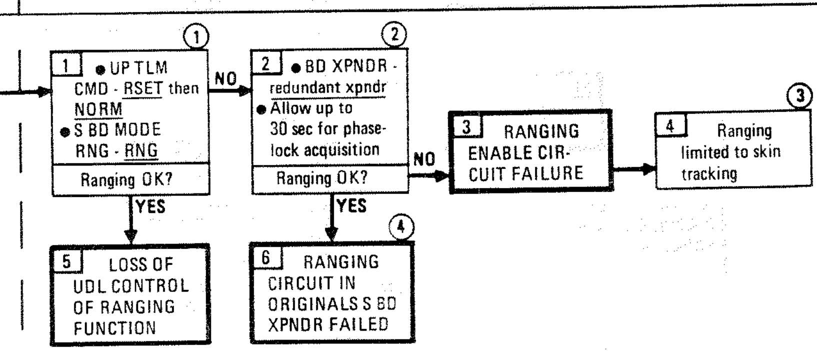
9 MSFN REPORTS LOSS OF RANGING



1 Coordinate with MSFN.

2 When S BD XPNDR - redundant xpndr, hesitate momentarily in OFF.

3 Skin tracking performed by ground radar; no crew action required.

4 Original XPNDR is usable for all functions except ranging.

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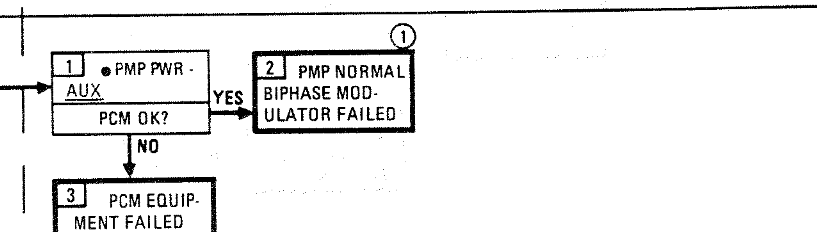
10 MSFN REPORTS LOSS OF REAL TIME PCM

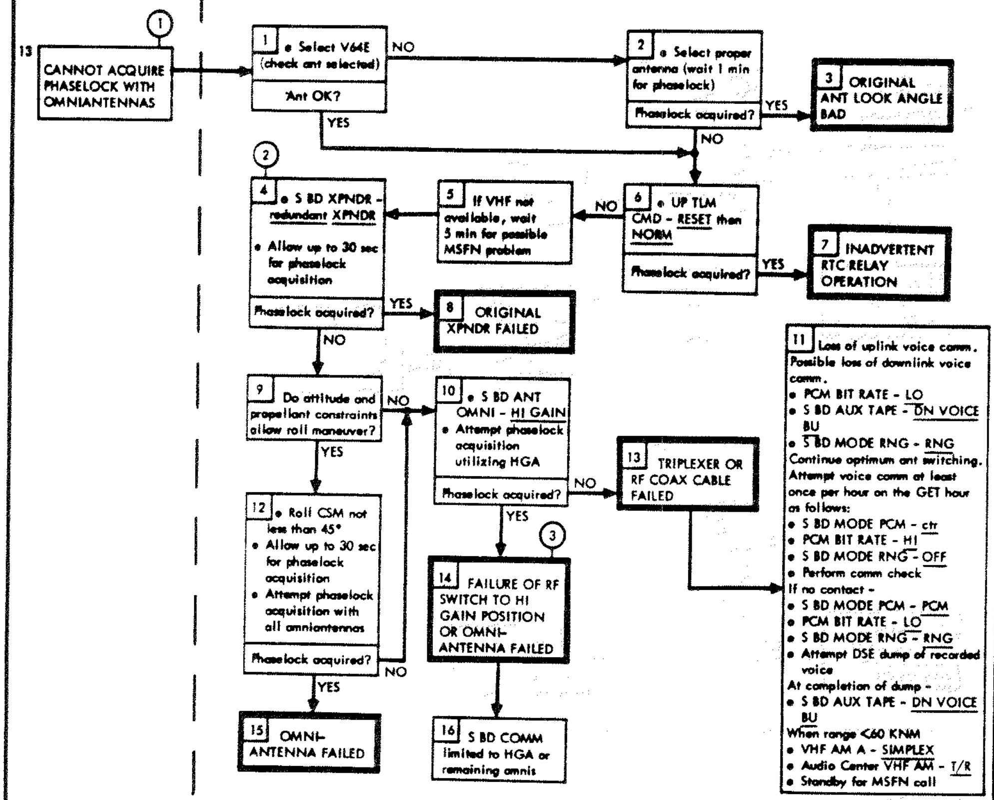


1 The capability is lost to transmit recorded PCM simultaneously with real time PCM.

SM-2A-2261

SYMPTOM	PROCEDURE	REMARKS
11 HI GAIN ANTENNA DOES NOT RESPOND PROPERLY TO MANUAL POINTING COMMANDS ①	1 • HI GAIN ANT SERVO ELEC - redundant servo electronics. Antenna responds properly? YES → 4; NO → 2. 2 ② • HI GAIN ANT BEAM - WIDE • Assure phaselock achieved • Rotate each of the HGA dials (Max travel). Signal strength varys? YES → 3; NO → 5. 3 INDICATOR CIRCUITRY FAILED 4 ORIGINAL ELECTRONICS FAILED 5 Is this initial HGA activation? YES → 6; NO → 8. 6 Perform CSM yaw left, pitch down attitude maneuver. Indicators respond properly? YES → 7; NO → 8. 7 ANTENNA LOCKING MECHANISM WAS NOT LOCKED IN PLACE 8 ③ • Switch to omni antennas • HI GAIN ANT PWR - OFF (for 20 min) then PWR • Manually command antenna movement. HGA follows manual commands? YES → 10; NO → 9. 9 ④ HGA PARTIALLY OR TOTALLY IMMOBILIZED 10 TEMPORARY BINDING OF THE GIMBAL DRIVE MECHANISM	① Assumes that MANUAL MODE has been selected and that both HGA command dials have been rotated back and forth ≈30° several times. ② If antenna pointing is incorrect, phaselock can still be achieved but with a reduced signal strength. ③ If HGA usage mandatory orient CSM with HGA pointed toward earth; HI GAIN ANT BEAM - NARROW. Rotate HGA pitch and yaw command dials to correspond to meter readings. ④ Indicators will display actual antenna position. If look angle is outside shadow area HGA may be utilized when CSM attitude permits.
12 CANNOT ACQUIRE OR MAINTAIN PHASELOCK WITH HIGH GAIN ANTENNA ①	1 Assure that earth LOS is not within shadow area. HGA does not respond properly to manual pointing commands? YES → 2; NO → T/C 11 1 (HI GAIN ANTENNA DOES NOT RESPOND PROPERLY TO POINTING COMMANDS). 2 • UP TLM CMD - RSET then NORM. Phaselock acquired? YES → 5; NO → 3. 3 If VHF not available, wait 5 min for possible MSFN problem • HI GAIN ANT SERVO ELEC - redundant elec. Phaselock acquired? YES → 4; NO → 6. 4 ORIGINAL HGA SERVO ELECTRONICS FAILED 5 INADVERTENT RTC RELAY OPERATION 6 Select omni antenna • Select favorable omni antenna • V64E (if necessary). Phaselock acquired? YES → 7; NO → 8. 7 Restore voice comm • PCM BIT RATE - LO • S BD AUX TAPE - DN VOICE BU • Reattempt voice contact • Reselect HI GAIN ANT → 10. 8 ② • S BD XPNDR - redundant xpndr • Allow up to 1 min for phase lock acquisition. Phase lock acquired? YES → 9; NO → 13. 9 ORIGINAL XPNDR FAILED 10 ③ • HI GAIN ANT BEAM - WIDE or NARROW (alternate position). Phaselock acquired? YES → 11; NO → 14. 11 MICROWAVE WIDE OR NARROW TRACKING CIRCUITRY FAILED 12 Attempt voice comm at least once per hour on the GET hour as follows: • S BD MODE PCM - ctr • PCM BIT RATE - HI • S BD MODE RNG - OFF • Perform comm check. If no contact • S BD MODE PCM - PCM • PCM BIT RATE - LO • S BD MODE RNG - RNG • Attempt DSE dump of recorded voice. At completion of dump • S BD AUX TAPE - DN VOICE BU. When range <60K NM • VHF AM A - SIMPLEX • Audio center VHF AM - T/R • Standby for MSFN call 13 TRIPLEXER OR RF COAX CABLE FAILED → 16 14 Can phaselock be acquired in manual? YES → 15; NO → 17. 15 AUTO TRACK CIRCUITRY FAILED → 18 16 Loss of uplink voice comm. Possible loss of downlink voice comm • PCM BIT RATE - LO • S BD AUX TAPE - DN VOICE BU • S BD MODE RNG - RNG. Continue optimum ant switching → 12 17 HGA MICROWAVE ELECTRONICS FAILED 18 • Utilize omni antenna or • Utilize HGA in manual mode	① Loss of uplink phaselock is indicated by noise in headset and S-BD antenna ind <30%. ② When SBD XPNDR-redundant xpndr, hesitate momentarily in OFF. ③ If in medium select wide.

SYMPTOM	PROCEDURE	REMARKS

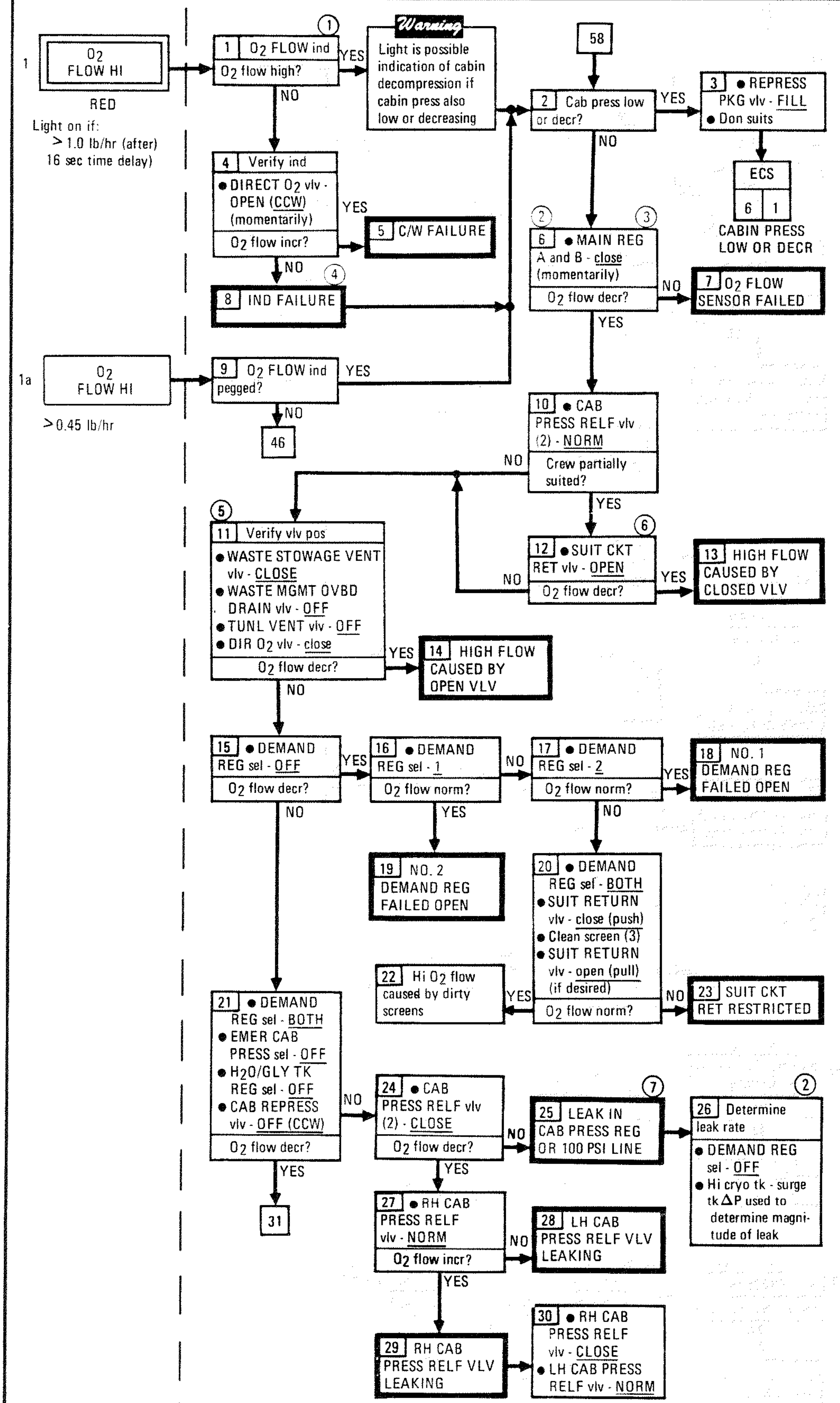


1 Loss of uplink phaselock is indicated by noise in headset and S BD antenna ind <30%.

2 When SBD XPNDR-redundant xpndr, hesitate momentarily in OFF.

3 Performing roll maneuver eliminates omniantenna as failure.

SYMPTOM	PROCEDURE	REMARKS



(1) Normal range 0.25 to 0.45 lb/hr.

(2) A surge tank - cryo tank ΔP of 50 psi will verify a high O_2 flow. Typical HI CRYO TK-SURGE TK ΔP:

- 50 psi ≈ 1.0 lb/hr
- 100 psi ≈ 2.5 lb/hr
- 150 psi ≈ 3.5 lb/hr
- 400 psi ≈ 5.5 lb/hr

(3) Placing the MAIN REG A & B - closed and noting a decrease in O_2 flow will validate the sensor indication.

(4) Continue with O_2 Flow Hi procedure and use C/W lt and surge tank bleed down as indication of O_2 flow.

(5) This action verifies that inadvertently opened valve has not caused increased O_2 flow. However, high O_2 flow normal during cabin gas changeover.

(6) Assumes partially suited mode is:

- SUIT CKT RET vlv - open
- DEMAND REG vlv - BOTH

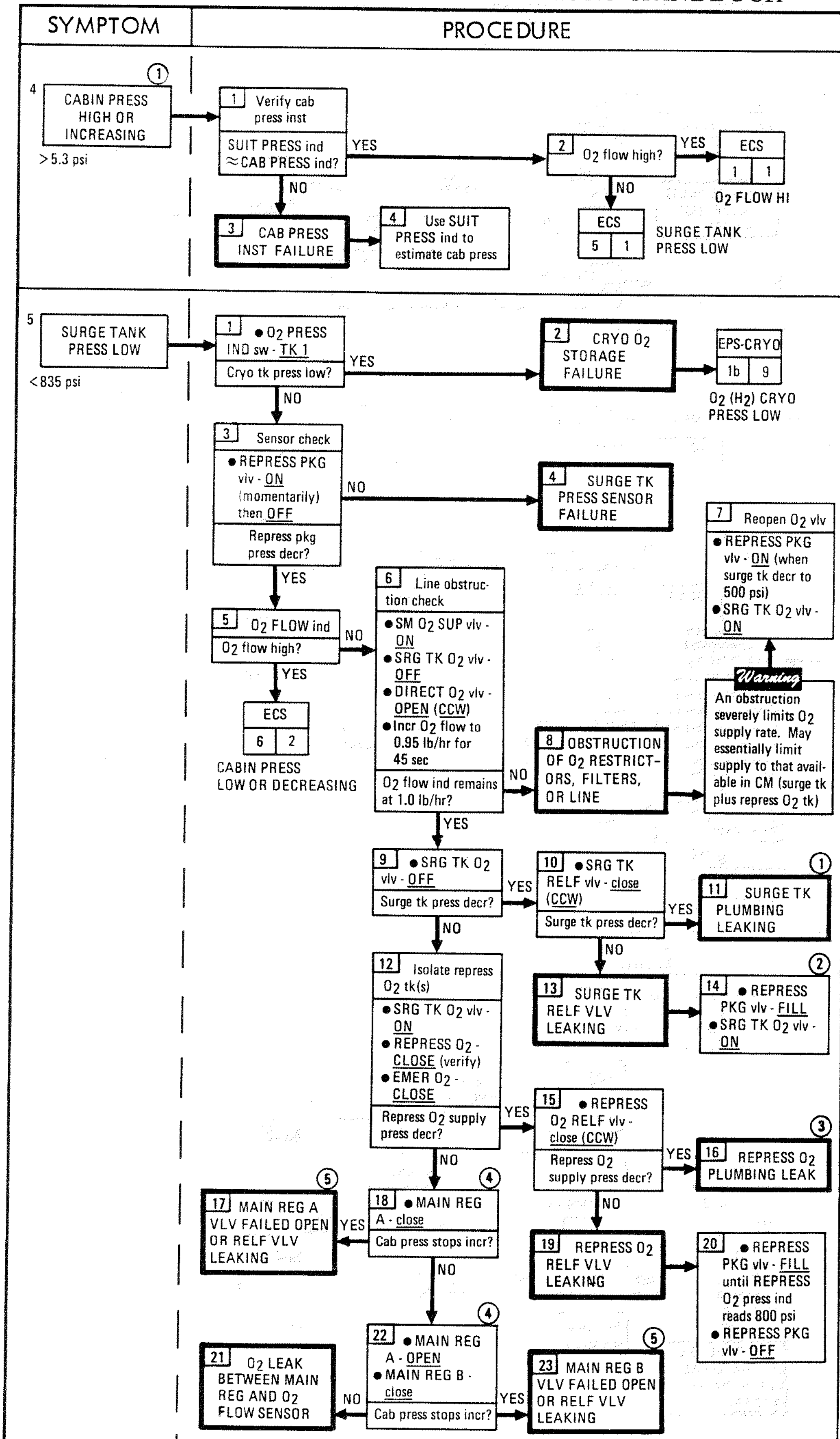
(7) If leak is not isolated and O_2 flow remains high, mission time may be extended by shutting off the main O_2 regulators, re-opening them when necessary to maintain cabin pressure and for actuation of the cyclic accumulators. Placing the WASTE STOWAGE VENT valve to VENT may prevent the cabin relief valve from actuating.

SM-2A-2251

ECS MALFUNCTION

SYMPTOM	PROCEDURE	REMARKS
1a (Cont)	21 → 31 31 Crew suited? YES → 32; NO → 35 32 Is waste H_2O qty decr rapidly? YES → ECS 28b 17 WASTE H_2O QTY DECR RAPIDLY; NO → 33 33 ● H_2O/GLY TK REG sel - 1 ● H_2O/GLY TK RELF sel - 1. O_2 flow incr? YES → 34; NO → 37 34 H_2O/GLY TK PRESS REG VLV 1 OR RELF VLV 1 FAILED OPEN (8) → 38 35 EMER CAB PRESS sel - BOTH. O_2 flow norm? YES → 32; NO → 39 36 CAB REPRESS VLV LEAKING 37 ● H_2O/GLY TK REG sel 2 ● H_2O/GLY TK RELF sel - 2. O_2 flow incr? YES → 42; NO → 36 38 Continue operation on unaffected reg and/or relf vlv 39 (9) ● EMER CAB PRESS TEST pb - push (several times). O_2 flow decr? YES → 43; NO → 40 40 ● EMER CAB PRESS sel - 1. O_2 flow decr? YES → 44; NO → 41 41 No. 1 EMER CAB PRESS REG FAILED OPEN → 45 42 (8) H_2O/GLY TK PRESS REG VLV 2 OR RELF VLV 2 FAILED OPEN → 38 43 TEMPORARY PEEL VLV SEATING PROBLEM 44 NO. 2 EMER CAB PRESS REG FAILED OPEN 45 ● EMER CAB PRESS sel - 2 9 → 46 46 Check flow sensor ● MAIN REG A and B - CLOSE (momentarily). O_2 flow decr? YES → 47; NO → 50 47 ● SUIT H_2O ACCUM AUTO - redundant accum. O_2 flow decr? YES → 51; NO → 48 48 (10) ● SUIT H_2O ACCUM AUTO - ctr. O_2 flow decr? YES → 49; NO → 52 49 (11) (12) INCORRECT CENTRAL TIMER SIGNAL TO AUTO CYCLE CONTROL UNITS 50 O_2 FLOW SENSOR FAILED 51 (12) (13) NO. 1 OR 2 H_2O ACCUM FAILED ON 52 (14) Cycle accum solenoid vlvs ● SUIT CKT H_2O ACCUM ON - 1 then 2 (several times). O_2 flow decr? YES → 55; NO → 54 53 (12) (15) NO. 1 H_2O ACCUM SOLENOID VLV FAILED OPEN → 56 54 H_2O ACCUM 1 - OFF. O_2 flow decr? YES → 53; NO → 58 55 (12) H_2O ACCUM SOLENOID VLV FAILED OPEN → 57 56 ● SUIT H_2O ACCUM AUTO - 2 57 Return to orig sw configuration 58 ● H_2O ACCUM 2 - OFF ● H_2O ACCUM 1 - RMTE. O_2 flow decr? YES → 59; NO → 2 59 (12) (15) NO. 2 H_2O ACCUM SOLENOID VLV FAILED OPEN → 60 60 ● SUIT H_2O ACCUM AUTO - 1	(8) MSFN can distinguish between these two failures by reporting tank bladder pressure. (9) PRESS-TO-TEST operation may reseal leaky peel valve. (10) Removes power from H_2O accumulator. (11) H_2O accumulator can be manually operated. (12) Max O_2 bleed into suit loop will be 0.55 lb/hr (from which metabolic use and cabin leakage will be taken). (13) This failure does not necessarily preclude manual operation of the affected H_2O accumulator. (14) Cycling operation may free sticking valve. (15) Loss of electrical cyclic control of affected H_2O accumulator. Periodic manual valve operation the only means of actuating H_2O accumulator.
2 O_2 FLOW LOW (1) <0.25 lb/hr	1 Verify O_2 FLOW ind ● DIRECT O_2 vlv - OPEN (ccw) (momentarily). Mometary flow incr? YES → 2; NO → 4 2 (2) ● WASTE STOWAGE VENT vlv - VENT. O_2 flow >0.7 lb/hr? YES → 3; NO → 5 3 Low system demand → 6 4 (3) O_2 FLOW SNSR OR IND FAILURE 5 O_2 flow sensor calib shift → 6 6 ● WASTE STOWAGE VENT vlv - CLOSE	(1) Normal range 0.25 - 0.45 lb/hr. (2) May take up to 45 minutes max. (3) MSFN can distinguish between these two failures.
3 SURGE TANK PRESS HIGH >935 psi	1 Cryo tk press check ● O_2 PRESS IND sw - TK 1. Either cryo tk press hi? YES → 2; NO → 4 2 ● O_2 PRESS IND sw - SURGE TK ● REPRESS PKG vlv - FILL (momentarily). Repress pack O_2 meter incr >935 psi? YES → 3; NO → 5 3 CRYO O_2 STORAGE FAILURE → EPS-CRYO 1a 3 O_2 (H_2) CRYO PRESS HI 4 (1) SURGE TANK SENSOR FAILURE 5 (2) SURGE TK/CRYO TK 1 METER FAILURE	(1) Use highest cryo tank indication to estimate surge tank pressure. (2) Surge tank pressure may be determined by momentarily positioning REPRESS PKG vlv - FILL and read repress pack press meter after stabilization.

SM-2A-2252



REMARKS

① Cabin pressure >5.3 psi is normal after insertion. Normal range is 4.7 to 5.3 psi

① REPRESS PKG vlv - FILL; repress O_2 supply to perform surge tank function.

② Use REPRESS O_2 RELF vlv for surge tank pressure relief.

③ If subsequent O_2 mask use is necessary, position REPRESS PKG vlv to FILL. Excessive O_2 consumption results.

④ This step may require considerable time.

⑤ MSFN can distinguish between these two failures by reporting O_2 system pressure.

SM-2A-2253

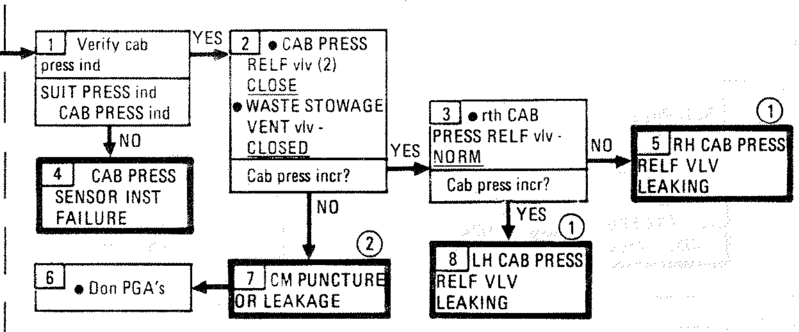
ECS MALFUNCTION

SYMPTOM | PROCEDURE | REMARKS

6

CABIN PRESS LOW OR DECREASING

<4.7 psi



1 Maintain closed position on leaking valve. Cabin pressure relief valve redundancy lost.

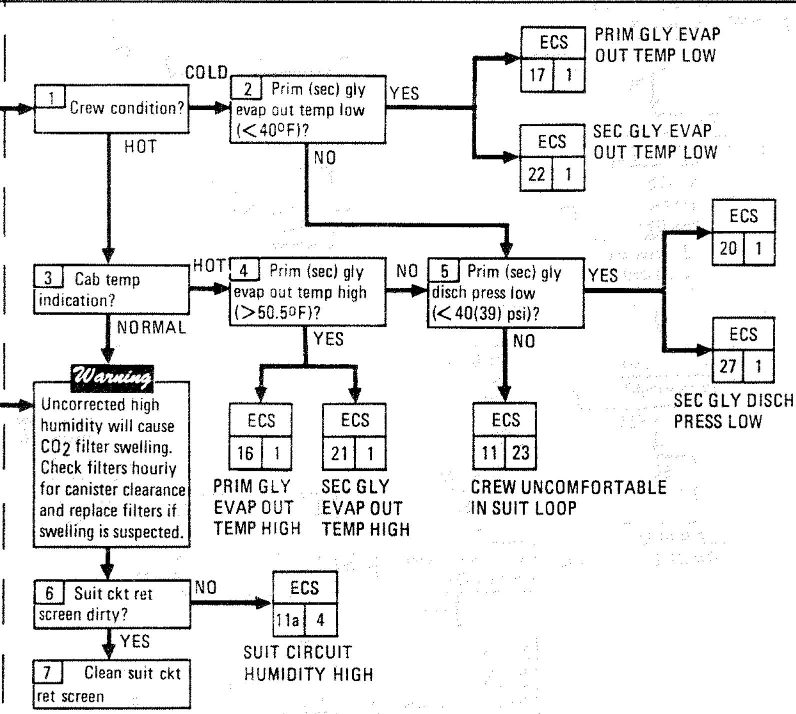
2 Maintain fully suited mode. Excessive O_2 consumption if cabin pressure is maintained. The suit circuit should be purged to eliminate accumulated H_2 as follows:
a. Periodic purge (every 6 hours) DIRECT O_2 vlv - open (fully) for one minute then closed.
b. After use of water gun for drinking provided O_2 supply permits DIRECT O_2 vlv - open (fully) for 8 seconds then closed.

7

CREW UNCOMFORTABLE IN CABIN

7a

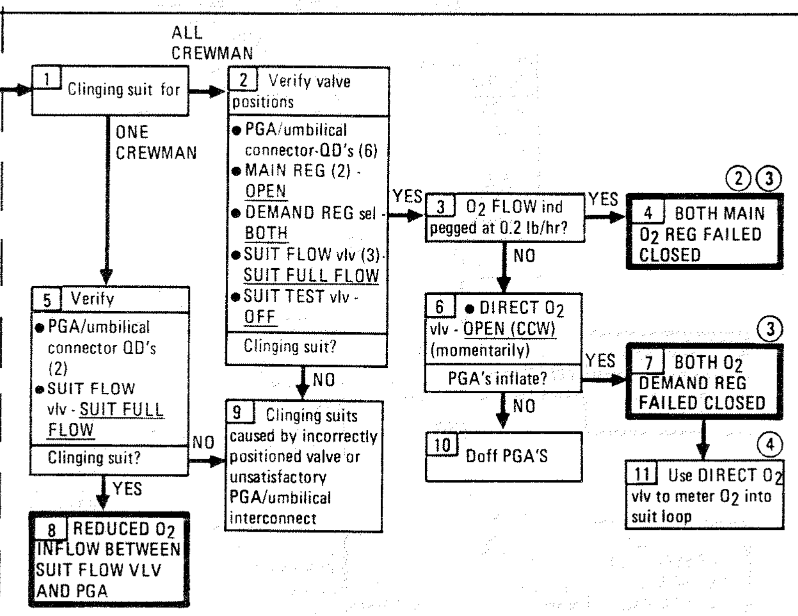
CABIN HUMIDITY HIGH



8 (1)

CLINGING SUIT

CAB PRESS>4.2 psi
Helmet/gloves doffed



1 Valid only for nonreserved hose configuration.

2 MSFN can verify loss of 100 psi circuit. Open/close REPRESS vlv to maintain ≈5 psia cabin press.

3 Doff PGA's closed suit operations are lost.

4 Metabolic requirement per crewman is approximately 0.1 lb/hr.

SM-2A-2254

SYMPTOM	PROCEDURE	REMARKS

9 SUIT COMPRESSOR RED

Light on if: Compressor ΔP <0.22 psi

9a SUIT COMPR ΔP LOW ②

<0.32 psi

1. Suit compr ΔP <0.22 psi? NO → 2; YES → 3
2. C/W FAILURE
3. Suit compr ΔP zero? YES → Warning; NO → 6

Warning: If suited, suit compressors may remain inoperative for no longer than one minute or asphyxiation may result. → 4

4. Check suit supply hose for flow (if in cabin mode). Suit flow? YES → 5; NO → 8
5. SUIT COMPR ΔP SENSOR FAILED ①
6. ③ ● Suspect SUIT COMPR 1 (or 2) - OFF. Suit compr ΔP drops to zero? NO → 7; YES → 8
7. SUIT COMPR INDICATOR FAILURE
8. Suit compr ck. ● Redundant SUIT COMPR - alternate bus. Suit compr ΔP incr? YES → 9; NO → 10
9. DEGRADED OR FAILED SUIT COMPR
10. Verify suit loop integrity. Suit compr ΔP incr? NO → 11; YES → 14
11. ● SUIT FLOW RELF - OFF. Suit compr ΔP incr? NO → 12; YES → 15
12. ● SUIT COMPR (both) - on alternate buses. Suit compr ΔP incr? YES → 13; NO → 16
13. DEGRADED OUTPUT OF BOTH COMPR. TWO COMPR OPERATION REQUIRED FOR CREW COMFORT.
14. SUIT LOOP INTEGRITY VIOLATED
15. Low ΔP caused by open SUIT FLOW RELF
16. ④ BOTH SUIT COMPR FAILED → 17
17. ⑤ ● WASTE STOWAGE VENT vlv - VENT. If required to maintain CO_2<7.6 mm Hg: ● DIRECT O_2 vlv - OPEN (CCW) as req ● cb SUIT COMPR (6) - open

Remarks:

① Subsequent compressor operation verified by monitoring supply hose flow and humidity level.

② Unsuited compressor ΔP of approximately 0.275 psid is normal with SUIT FLOW valve in SUIT FULL FLOW position.

③ Pressure rise across suit compressor is 0.36 psi in cabin mode (5.0 psi) and 0.26 psi at emergency suit pressure (3.75 psi). Suit compr ΔP of 0.1 psi will adequately scrub cabin air for unsuited operation.

④ Humidity and CO_2 control lost. Inadequate suit ventilation obtained by opening DIRECT O_2 vlv. PGAs will balloon up to 0.32 psi above cabin if in suited mode. Use emergency O_2 masks if in cabin mode since CO_2 indicator inoperative. Some consideration may be given to taping a CO_2 absorber element to the cabin fan inlet.

⑤ With this vent open CO_2 PP will remain<7.6 mm Hg for 77 minutes after compressors failed.

10 BALLOONED PGA'S ①

1. Suit press-cab press >1.0 psi? YES → 2; NO → 8
2. ● SUIT TEST vlv - OFF. O_2 flow decr? NO → 3; YES → 5
3. O_2 demand reg check. ● DEMAND REG sel - 1. Suit press decr? YES → 4; NO → 6
4. NO. 2 O_2 DEMAND REG FAILED OPEN
5. Ballooning caused by open SUIT TEST vlv
6. NO. 1 O_2 DEMAND REG FAILED OPEN → 7
7. ● DEMAND REG sel -2
8. ● DIRECT O_2 vlv - close (cw). O_2 flow decr? NO → 9; YES → 12
9. ② ● DEMAND REG sel - OFF. O_2 flow decr? YES → 10; NO → 13
10. ② ● DEMAND REG sel - 1. O_2 flow incr? YES → 11; NO → 14
11. ③ NO. 1 DEMAND REG EXCESS INTERNAL LEAK → 15
12. Ballooning caused by open DIRECT O_2 vlv
13. ● DEMAND REG sel - BOTH ● H_2O ACCUM (both) - OFF. O_2 flow decr? YES → 16; NO → 18
14. ③ NO. 2 DEMAND REG EXCESS INTERNAL LEAK → 15
15. ● DEMAND REG sel - redundant reg
16. ● H_2O ACCUM 1 - RMTE. O_2 flow incr? YES → 17; NO → 19
17. ④ NO. 1 H_2O ACCUM SOL VLV EXCESS INTERNAL LEAK → 20
18. UNIDENTIFIABLE INTERNAL LEAKAGE
19. ④ NO. 2 H_2O SOL VLV EXCESS INTERNAL LEAK
20. ● H_2O ACCUM 2 - RMTE

Remarks:

① Slightly ballooned can be verified by the suit-to-cabin ΔP indicator>zero. Cabin to suit ΔP maintained at 2.5 to 3.5 in. H_2O

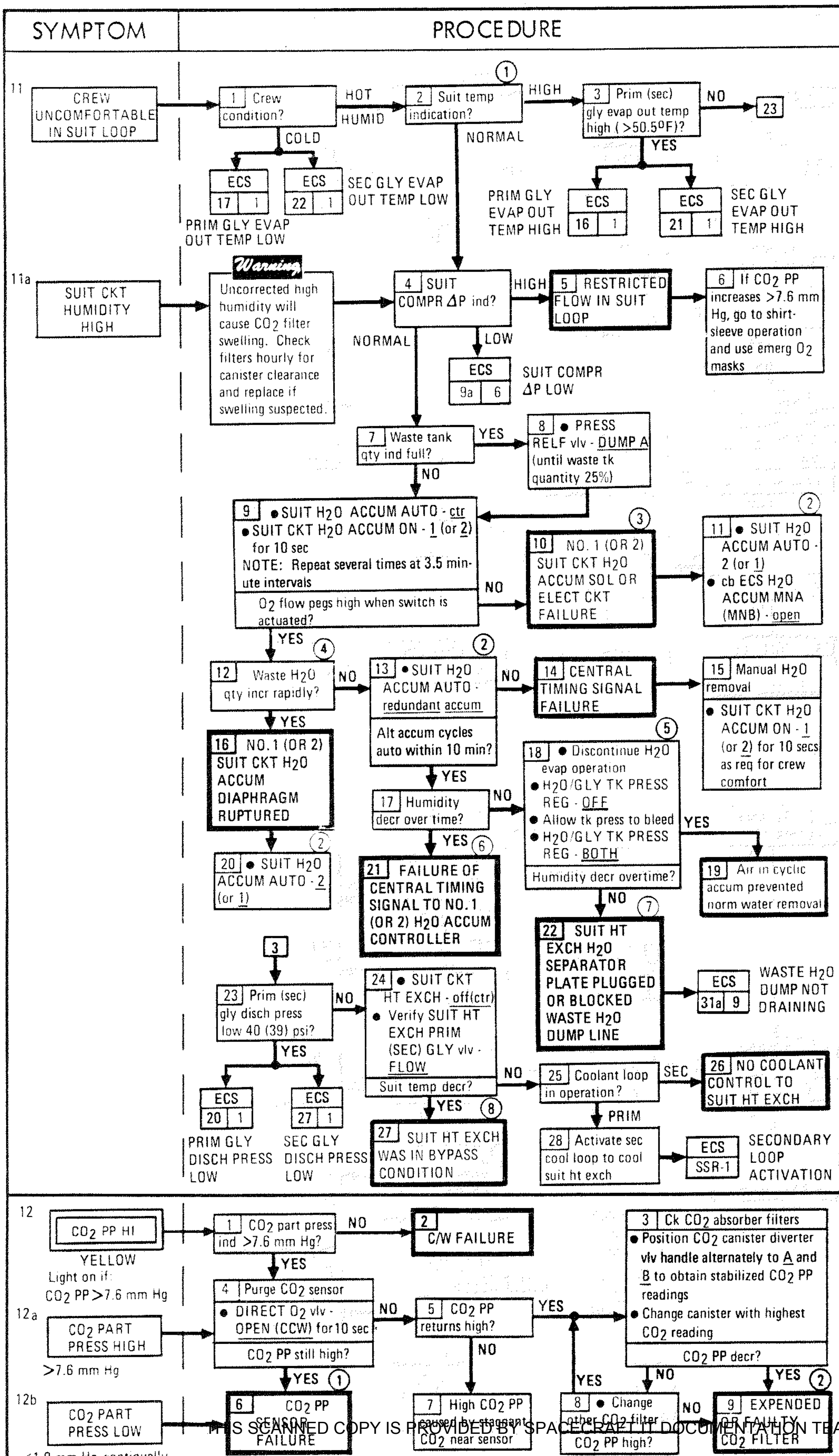
② Recycling valve several times may correct excessive O_2 flow.

③ Leaking O_2 demand regulator is still operational and may be used for depressurized cabin mode.

④ H_2O accumulators may be used manually for H_2O removal with excessive O_2 usage.

ECS MALFUNCTION

SM-2A-2255



REMARKS

(1) Assumes SUIT FLOW RELF valve is OFF.

(2) Operation is verified by O_2 FLOW indicator pegging high within a ten minute period. Accum cycle occurs at CTE - even 10 min marks (i.e. 0, 10, 20, etc.) and CTE clocks GET.

(3) Operation of No. 1 (or 2) H_2O accumulator may still be possible. This can be verified by placing H_2O ACCUM 1 (or 2) valve to MAN for 10 sec and then OFF noting a high O_2 flow while valve is in MAN position.

(4) If a rapid increase in waste water quantity is noted, release SUIT CKT H_2O ACCUM ON switch.

(5) Humidity and water coming out of suit supply hose should be greater than that caused by condensation from cold structure before proceeding to this step. This removes air from suit ckt H_2O accum. However, time for tank bleed-down is dependent upon the following waste H_2O tk quantities:

80%	1 hr
50%	3 hrs
20%	5 hrs

(MSFN reads H_2O gly tank press)

(6) Operation of No. 1 (or 2) H_2O accumulator still can be maintained by manual actuation of solenoid switch or manual operation of selector valve.

(7) A blocked waste H_2O dump line can be concluded if the waste H_2O tank qty were verified full in step 7.

(8) Suit heat exchanger must be bypassed manually for future use. In the primary ht exchanger mode, this failure could be caused by a motor or control switch failure.

(1) The CO_2 PP HI warning light may be extinguished by pulling the ECS PRESS XDUCER 2 MNA cb. However, this eliminates redundant MN bus pwr sources to the following sensors:
- Cabin press ind
- O_2 flow ind
- Gly stm press ind (Pri)
- O_2 manifold press (MSFN).

(2) Manual CO_2 partial pressure control can be accomplished by use of direct O_2 vlv operation, or emergency O_2 masks can be used.

SM-2A-2256

SYMPTOM	PROCEDURE	REMARKS

13 ① CO2 FILTER SEIZURE WITHIN CANISTER

PROCEDURE

1 EXCESSIVE SWELLING OF CO_2 FILTER

2 Single canister operation
- SUIT FLOW RELF - OFF
- CO_2 cstr divert vlv - both (ctr)
- Divert flow through siezed filter momentarily when replacement of operational filter is required.
- Use CO_2 PP ind as filter replacement ind

REMARKS

① Immediately replace a filter suspected of swelling.

---

14 GLYCOL TEMP LOW

YELLOW
Light on if:
RAD PRIM OUT TEMP ind $\leq$-30°F

14a PRIM ECS RAD OUT TEMP LOW
< -20°F

PROCEDURE

① 1 Rad prim out temp ind <-30°F? — NO: 2 C/W FAILURE; YES: step 3

② 3
- RAD PRIM HTR - redundant htr

Rad prim temp in incr? — NO: step 4; YES: 7 PRIM HTR CIRCUIT FAILURE

③ 4
- RAD PRIM HTR - off (ctr)

Gly evap prim out temp > 50.5°F? — NO: step 5; YES: ECS 16 2 PRIM GLY EVAP OUT TEMP HIGH

④ 5 Gly evap operation
Gly evap prim out temp < 43° and gly evap prim stm press < 0.14 psi? — NO: step 6; YES: ECS 17 1 PRIM GLY EVAP OUT TEMP LOW

6 Determine deadhead discharge pressure
- RAD MAN SEL - off (ctr)
- RAD FLOW CONT PWR - MAN SEL
- Wait 25 sec and record gly disch press

⑤ 8 Ck for frozen rad
- RAD MAN SEL - RAD 1

Gly disch prim press equal deadhead press? — NO: step 9; YES: 11 RAD 1 PANEL STAGNATED

9
- RAD MAN SEL - RAD 2

Gly disch prim press equal deadhead press? — NO: ⑥ 10 PRIM RAD OUT TEMP SENSOR FAILURE; YES: 12 RAD 2 PANEL STAGNATED

13
- RAD PRIM HTR - 1

⑦ 14 Thaw stagnated panel
- Orient CSM to direct stagnated panel toward sun
- RAD FLOW CONT AUTO - 1
- RAD FLOW CONT PWR - PWR
- Wait 17 sec for isolation vlv to position
- RAD FLOW CONT PWR - off (ctr)

⑧ 15 Verify thawing by repeating step 8 at approx 20 min intervals.
NOTE: If failure continues, isolate blocked panel and orient CSM for most favorable heat rejection

16 Resume normal rad operation
- RAD PRIM HTR - 1
- RAD FLOW CONT PWR - PWR
- RAD FLOW CONT AUTO - AUTO

REMARKS

① Because of thermal constraints involved there would be time to verify ECS rad out temp with MSFN as rad temp was dropping.

② Htr operation can be confirmed during sw operation by Δcurrent (15 amps for full htr vs 7½ amps for single element).

③ Heater is shut off to avoid possibility of boiling glycol in lines with low flow rates.

④ MSFN can aid in determining gly evap operation by comparing gly evap temp in and temp out.

⑤ Prim gly flow rate from MSFN can aid in determining frozen/stagnated panel.

If GLY DISCH PRIM PRESS is < 40 psi, go to:
ECS 20 1 GLY DISCH PRESS LOW

⑥ Use norm prim rad in temp and absence of H_2O boiling to estimate prim rad out temp.

⑦ Panel 1 between +Y and +Z, Panel 2 between -Y and -Z.

⑧ Rad flow blockage cannot be distinguished from stagnated panel. Reduce elec loads for single panel operation.

---

15 ① PRIM ECS RAD OUT TEMP HIGH
> 65°F
(> 80°F for lunar orbit)

PROCEDURE

1 Gly disch prim press < 40 psi — NO: step 2; YES: ECS 20 1 PRIM GLY DISCH PRESS LOW

② 2 Gly evap prim stm press ind
Water boiling (0.09-0.14 psi)? — YES: step 3; NO: step 5

③ 3
- RAD PRIM HTR - off (ctr)

ECS rad prim in temp decr? — YES: 4 PRIM 1 HTR FAILED ON → 7 • RAD PRIM HTR - 2; NO: step 6

5 Gly evap prim out temp > 50.5°F? — YES: ECS 16 1 PRIM GLY EVAP OUT TEMP HIGH; NO: ④ 8 PRIM RAD OUT TEMP INST FAILURE

6 Check redundant flow cont
- RAD FLOW CONT AUTO - redundant cont

ECS rad temp prim out decr? — YES: 9 FLOW PROPORTIONING CONT OR ISOLATION VLV FAILURE → 13 • RAD PRIM HTR - 1; NO: step 12

12 Determine deadhead discharge press
- Record gly disch press
- RAD MAN SEL - off (ctr)
- RAD FLOW CONT PWR - MAN SEL
- Wait 25 sec and record gly deadhead disc press

Did press increase? — YES: ECS 14 8 GLYCOL TEMP LOW; NO: step 11

⑤ 11 POWER TO NO. 1 FLOW CONT AND RAD ISOLATION VALVES FAILED

10
- RAD FLOW CONT PWR - PWR
- RAD FLOW CONT AUTO - 1
- Initiate PTC

REMARKS

① Primary radiator outlet temperature > 65°F not abnormal when associated with high electrical loads (> 2000 watts).

② PRIM GLY EVAP STM PRESS readings of 0.09 and 0.14 psi correspond to PRIM GLY EVAP OUT TEMP readings of 38° and 43°F, respectively.

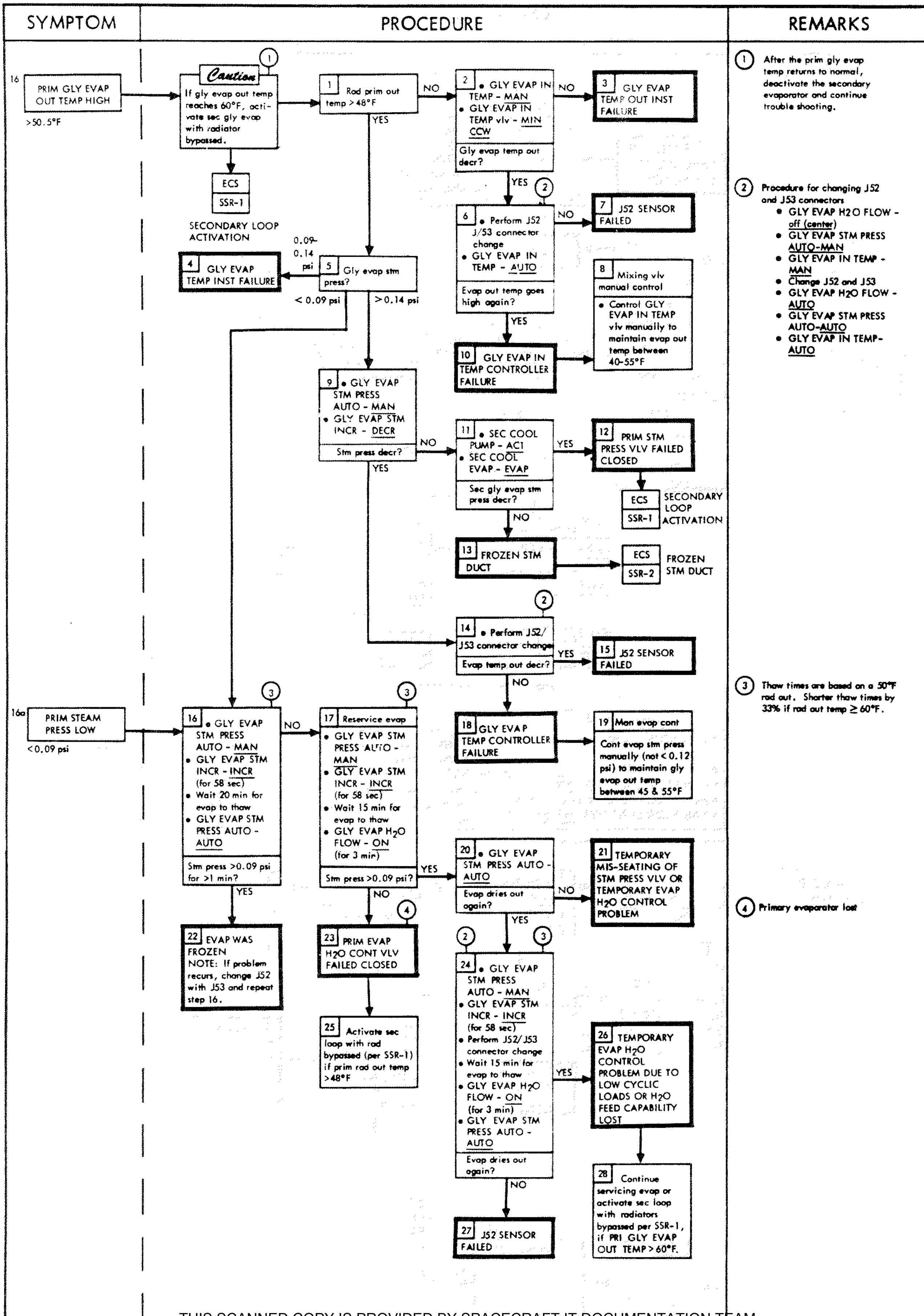
③ Heater operation may be confirmed during switching operation by Δ current (15 amps for full heater vs 7½ amps for single element.

④ Primary radiator inlet temperature and absence of water boiling can be used to estimate primary radiator outlet temperature.

⑤ Flow proportioning valve not available in system No. 1 due to power loss, nor in system No. 2 due to inoperative rad isolation valves. Check cb RAD CONTR AC1.

SM-2A-2257

ECS MALFUNCTION


SYMPTOM
PROCEDURE
REMARKS
16
PRIM GLY EVAP OUT TEMP HIGH
>50.5°F
Caution
If gly evap out temp reaches 60°F, activate sec gly evap with radiator bypassed.
ECS
SSR-1
SECONDARY LOOP ACTIVATION
1 Rad prim out temp >48°F
NO
YES
2 • GLY EVAP IN TEMP - MAN
• GLY EVAP IN TEMP vlv - MIN CCW
Gly evap temp out decr?
3 GLY EVAP TEMP OUT INST FAILURE
6 • Perform J52 J/53 connector change
• GLY EVAP IN TEMP - AUTO
Evap out temp goes high again?
7 J52 SENSOR FAILED
8 Mixing vlv manual control
• Control GLY EVAP IN TEMP vlv manually to maintain evap out temp between 40-55°F
10 GLY EVAP IN TEMP CONTROLLER FAILURE
4 GLY EVAP TEMP INST FAILURE
5 Gly evap stm press?
0.09-0.14 psi
< 0.09 psi
> 0.14 psi
9 • GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP STM INCR - DECR
Stm press decr?
11 • SEC COOL PUMP - AC1
• SEC COOL EVAP - EVAP
Sec gly evap stm press decr?
12 PRIM STM PRESS VLV FAILED CLOSED
ECS
SSR-1
SECONDARY LOOP ACTIVATION
13 FROZEN STM DUCT
ECS
SSR-2
FROZEN STM DUCT
14 • Perform J52/J53 connector change
Evap temp out decr?
15 J52 SENSOR FAILED
16a
PRIM STEAM PRESS LOW
<0.09 psi
16 • GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP STM INCR - INCR (for 58 sec)
• Wait 20 min for evap to thaw
• GLY EVAP STM PRESS AUTO - AUTO
Stm press >0.09 psi for >1 min?
17 Reservice evap
• GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP STM INCR - INCR (for 58 sec)
• Wait 15 min for evap to thaw
• GLY EVAP H2O FLOW - ON (for 3 min)
Stm press >0.09 psi?
18 GLY EVAP TEMP CONTROLLER FAILURE
19 Man evap cont
Cont evap stm press manually (not <0.12 psi) to maintain gly evap out temp between 45 & 55°F
20 • GLY EVAP STM PRESS AUTO - AUTO
Evap dries out again?
21 TEMPORARY MIS-SEATING OF STM PRESS VLV OR TEMPORARY EVAP H2O CONTROL PROBLEM
22 EVAP WAS FROZEN
NOTE: If problem recurs, change J52 with J53 and repeat step 16.
23 PRIM EVAP H2O CONT VLV FAILED CLOSED
25 Activate sec loop with rad bypassed (per SSR-1) if prim rad out temp >48°F
24 • GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP STM INCR - INCR (for 58 sec)
• Perform J52/J53 connector change
• Wait 15 min for evap to thaw
• GLY EVAP H2O FLOW - ON (for 3 min)
• GLY EVAP STM PRESS AUTO - AUTO
Evap dries out again?
26 TEMPORARY EVAP H2O CONTROL PROBLEM DUE TO LOW CYCLIC LOADS OR H2O FEED CAPABILITY LOST
27 J52 SENSOR FAILED
28 Continue servicing evap or activate sec loop with radiators bypassed per SSR-1, if PRI GLY EVAP OUT TEMP >60°F.
1 After the prim gly evap temp returns to normal, deactivate the secondary evaporator and continue trouble shooting.
2 Procedure for changing J52 and J53 connectors
• GLY EVAP H2O FLOW - off (center)
• GLY EVAP STM PRESS AUTO-MAN
• GLY EVAP IN TEMP - MAN
• Change J52 and J53
• GLY EVAP H2O FLOW - AUTO
• GLY EVAP STM PRESS AUTO-AUTO
• GLY EVAP IN TEMP-AUTO
3 Thaw times are based on a 50°F rad out. Shorter thaw times by 33% if rad out temp ≥ 60°F.
4 Primary evaporator lost

SM-2A-1510R

SYMPTOM	PROCEDURE	REMARKS

17 PRIM GLY EVAP OUT TEMP LOW

< 38°F

1. Rad prim out temp < 50.5°F ? — NO: go to 2; YES: go to 8
2. Shutdown prim evap
   - GLY EVAP STM PRESS AUTO - MAN
   - GLY EVAP STM INCR - INCR (for 58 sec)

   Stm press incr > 0.14 psi? — YES: go to 3; NO: go to 6
3. PRIM GLY EVAP OUT TEMP ind incr to ≈ RAD PRIM OUT TEMP ind? — NO: go to 4; YES: go to 10
4. **PRIM GLY EVAP TEMP INST FAILURE** — go to 5 (1)
5. Reactivate prim evap
   - GLY EVAP STM PRESS AUTO - AUTO
   - GLY EVAP IN TEMP - AUTO
6. **STM PRESS CONTROL VLV FAILURE** — go to 7
7. - PRIM EVAP H_2O CONT - OFF
   - Activate sec cool loop (with rad bypassed) as reqd to maintain PRIM GLY EVAP OUT TEMP < 60°F

   → ECS SSR-1 SECONDARY LOOP ACTIVATION
8. - GLY EVAP STM PRESS AUTO - MAN
   - GLY EVAP STM INCR - INCR (for 58 sec)

   Stm press incr? — YES: go to 9; NO: go to 12
9. Gly evap temp out incr? — YES: go to 10; NO: go to 13 (3)
10. Perform J52/J53 connector change (2)

    Gly evap temp out normal (38-50.5°F)? — NO: go to 11; YES: go to 14
11. **GLY EVAP TEMP CONTROLLER FAILURE** — go to 15
12. - GLY EVAP IN TEMP - MAN
    - GLY EVAP IN TEMP vlv - MAX CW

    Gly evap temp out incr? — YES: go to 16; NO: go to 17
13. **DOUBLE FAILURE**

    GLY EVAP TEMP CONTROLLER & INST FAILURE OR GLY EVAP TEMP CONTROLLER & GLY EVAP INLET TEMP VLV FAILURE
14. **J52 SENSOR FAILURE**
15. Man evap cont

    Cont evap stm press manually (not < 0.12 psi) to maintain gly evap out temp between 45-55°F
16. - Perform J52/J53 connector change

    Gly evap temp out goes low again? — NO: go to 14; YES: go to 19
17. **GLY EVAP TEMP OUT INST FAILURE** — go to 18
18. Reactivate prim evap (1)
    - GLY EVAP STM PRESS AUTO - AUTO
    - GLY EVAP IN TEMP - AUTO
19. **GLY EVAP TEMP IN CONTROLLER FAILURE** — go to 20
20. Manually control gly evap temp out between 35-60°F by adjusting prim gly evap temp in vlv

REMARKS

(1) An estimate of gly evap out temp can be made from steam press conversion and/or suit temp-5°F (unsuited); -10°F (suited).

(2) Procedure for connector change
- GLY EVAP H_2O FLOW - off (center)
- GLY EVAP STM PRESS AUTO - MAN
- GLY EVAP IN TEMP - MAN
- Change J52 with J53
- GLY EVAP H_2O FLOW - AUTO
- GLY EVAP STM PRESS AUTO - AUTO
- GLY EVAP IN TEMP - AUTO

(3) Changing J52 and J53 may possibly correct the glycol evap control problem.

18 PRIM GLY ACCUM QTY HIGH (1)

> 65%

Warning: If accum qty > 100%, set RAD PRIM HTR - off (ctr) before troubleshooting — go to 1

1. - GLY PUMPS - OFF (momentarily) (2)

   Gly disch press compatible with ind gly accum qty? — NO: go to 2; YES: go to 7
2. Pump disch press > 25 psi? — NO: go to 3; YES: go to 6
3. **GLY ACCUM QTY IND FAILED**

18a PRIM GLY DISCH PRESS HIGH

> 56 psi or > $\frac{\text{accum qty}}{4}$ +40

4. - GLY PUMPS - OFF (momentarily) (2)

   Gly disch press compatible with ind gly accum qty? — NO: go to 5; YES: go to 7
5. Accum quantity < 100%? — NO: go to 6; YES: go to 8
6. **LOCALIZED BOILING IN GLYCOL LINE BY RAD HTR** (3) — go to 9
7. - RAD PRIM HTR - off (ctr)
   - GLY RSVR IN vlv - OPEN then CLOSE

   NOTE: GLY RSVR IN vlv should be rapidly cracked open and then closed

   Gly accum qty incr again? — NO: go to 10; YES: go to 11
8. **GLY DISCH PRESS IND FAILED**
9. - RAD PRIM HTR - off (ctr)
   - PRIM ACCUM FILL vlv - ON then OFF
10. Transient condition caused by incr in gly accum qty
11. **ACCUM FILL VLV LEAKING** — go to 12
12. - RAD PRIM HTR - (orig config)

REMARKS

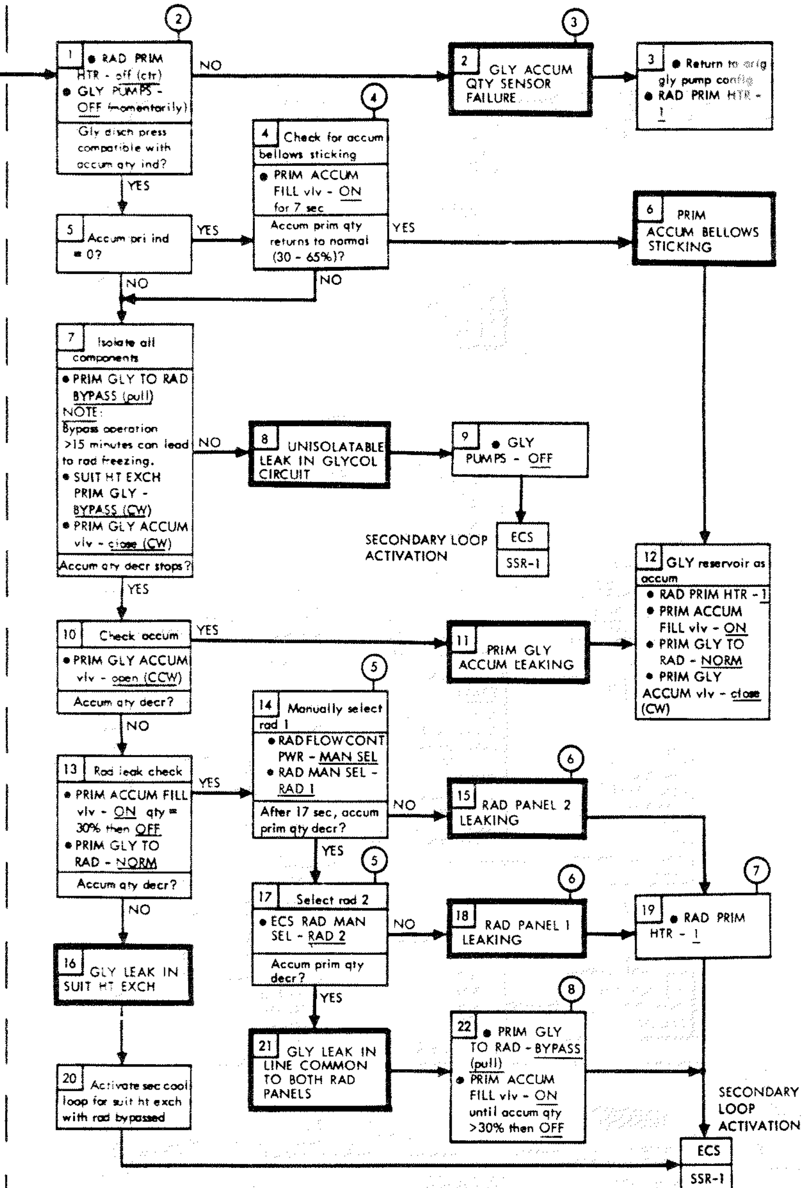
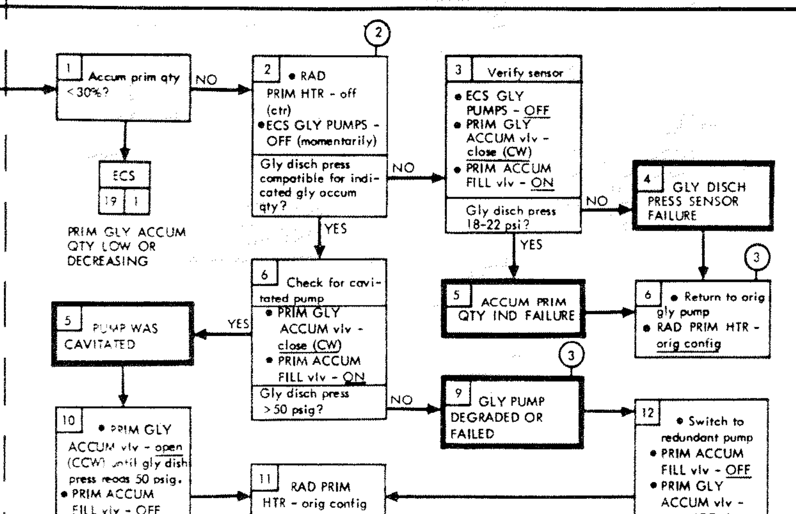
(1) PRIM ACCUM QTY ind > 65% may result in accum bellows sticking. If sticking occurs, cycle ECS prim glycol pumps.

(2) With GLY PUMPS - OFF, PRIM GLY DISCH PRESS should be 1/4 accum quantity.

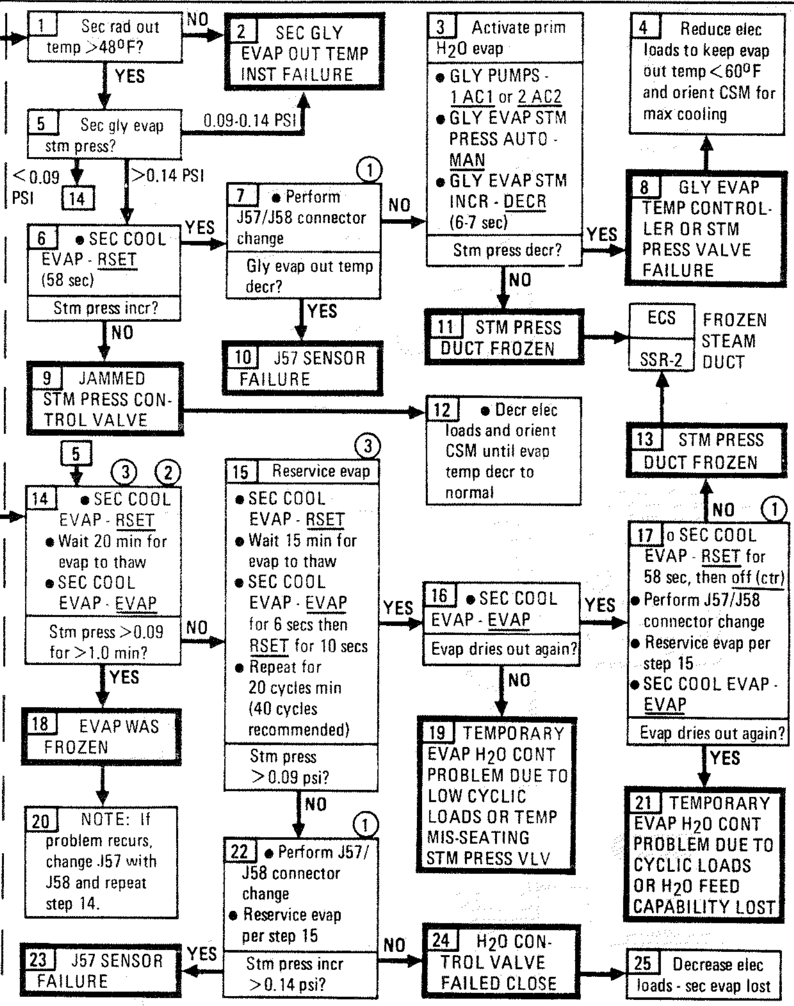
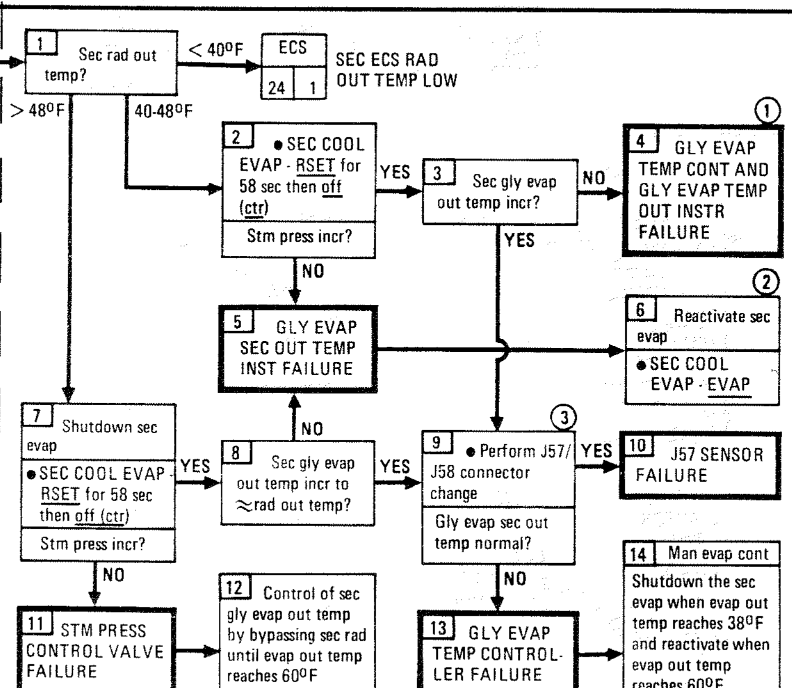
(3) Localized boiling could have been caused by a reduction in glycol flow due to failed radiator isolation valve or a frozen radiator, or due to incorrect positioning of:
- GLY RSVR vlv (3)
- PRIM GLY TO RAD vlv
- SUIT HT EXCH PRIM GLY vlv

Radiator restrictions can be determined by 4 to 6 psi drop in PRIM GLY DISCH PRESS when the radiators are bypassed.

SM-2A-1511N

SYMPTOM	PROCEDURE	REMARKS
19 (1) PRIM GLY ACCUM QTY LOW OR DECREASING < 30%		(1) Normal range is 30-65% Sensor powered by cb ECS PRESS XDUCER 1 MDC-5. If the glycol leak is slow (~5%/hr) the leak source may be more rapidly detected by momentarily placing the gly accum vlv off after each component is isolated. (2) With pump off, glycol disch press should equal 1/4 accumulator quantity. (3) Use gly disch press when pump off (momentarily) to estimate accum qty ind. With GLY PUMPS - OFF accumulator quantity should be 4 times pump disch press. (4) Cycling the primary ECS glycol pump may free a sticking accumulator bellows. (5) Radiator isolation valves take 17 sec to position. (6) Half of radiator heat rejection capability lost. (7) The secondary radiator will freeze unless secondary coolant loop activated. (8) Use primary coolant loop in evaporative mode when required for G&N operation. Constraints are evaporator H_2O consumption.
20 (1) PRIM GLY DISCH PRESS LOW < 40 psi or < $\frac{\text{accum qty}}{4}$ +32 psi		(1) With radiators by-passed, pump disch press is nominally 2 psi lower than with radiators operating. (2) With GLY PUMPS - OFF, glycol discharge press should equal 1/4 accumulator quantity indication. (3) Degraded glycol pump may be verified by checking GLY PRIM COLDPLATE flow rate with MSFN.

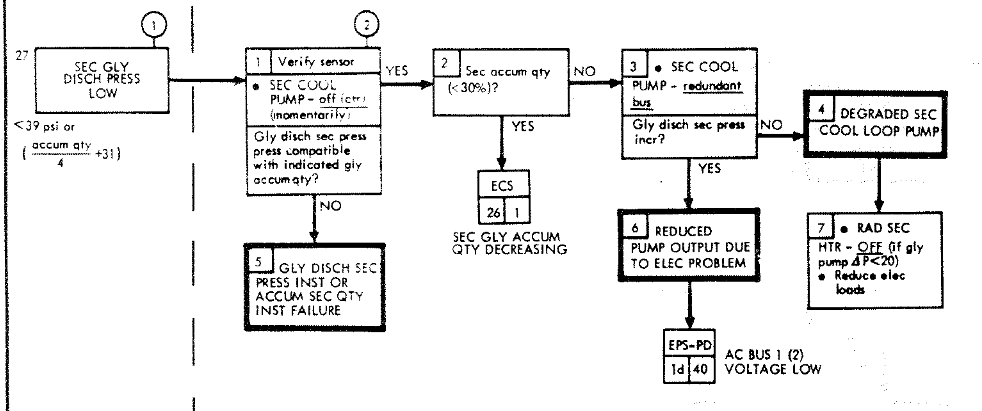
SM-2A-1661J

SYMPTOM	PROCEDURE	REMARKS
21 SEC GLY EVAP OUT TEMP HIGH >50.5°F; 21a SEC STEAM PRESS LOW <0.09 psi		① Procedure for changing J57 and J58 connectors: • SEC COOL EVAP - off (ctr) • Change connectors • SEC COOL EVAP - EVAP ② Repetition of this step may be necessary. ③ Thaw times are based on a 50°F rad out temp. Shorter thaw times at 33% if rad out temp ≥60°F.
22 SEC GLY EVAP OUT TEMP LOW <38°F		① Changing J57 with J58 may possibly correct the gly evap temp controller problem. ② Infer secondary glycol evaporator outlet temperature from secondary glycol evaporator steam pressure indication. ③ Procedure for changing J57 and J58 connectors: • SEC COOL EVAP - off (ctr) • Change connectors • SEC COOL EVAP - EVAP

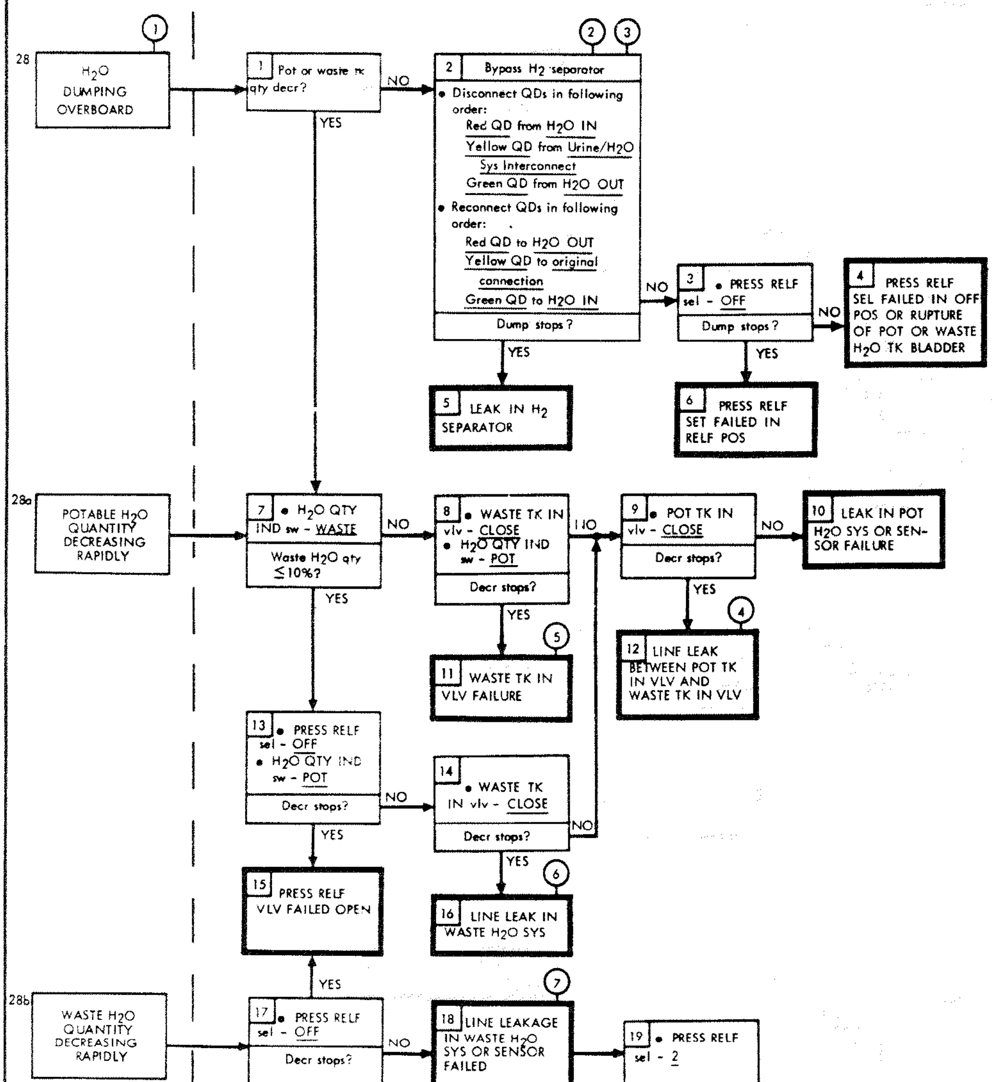
SM-2A-2259

SYMPTOM	PROCEDURE	REMARKS
23 SEC ECS RAD OUT TEMP HIGH >70°F (except for Lunar Orbit)	1 Sec gly disch press <39 psi? — YES: ECS 27 1 SEC GLY DISCH PRESS LOW; NO: go to 2 2 Sec gly evap operating normally? (stm press 0.1 - 0.14 psi) — YES: go to 5; NO: go to 3 3 Sec gly evap out temp >50.5°F — YES: ECS 21 1 SEC GLY EVAP OUT TEMP HIGH; NO: go to 4 4 SEC RAD OUT TEMP INST FAILURE 5 (1) Deactivate htr • RAD SEC HTR - OFF. Sec rad in temp decr? — YES: go to 6; NO: go to 8 6 SEC HTR FAILED ON → 7 7 Manually cont htr • Monitor RAD SEC OUT TEMP ind • Above 48°F, RAD SEC HTR - OFF • Below 40°F, RAD SEC HTR - SEC 8 EXCESSIVE HEAT LOAD FOR SEC COOL LOOP → 9 9 • Decr sec ECS heat load • RAD SEC HTR - SEC	(1) Heater operation can be confirmed by ammeter change during switching operation. Δ current will be: 30 amp - both operating 15 amp - one operating
24 (1) SEC ECS RAD OUT TEMP LOW < 38°F	1 Does gly evap sec out temp = rad sec out temp? — YES: go to 2; NO: go to 5 2 (2) Sec htr check • Check total CSM current • RAD SEC HTR - OFF • Check total CSM current. Both htrs operating? — YES: go to 3; NO: go to 6 3 Reactivate htr • RAD SEC HTR - SEC. Sec gly disch press <39 psi? — YES: ECS 27 1 SEC GLY DISCH PRESS LOW; NO: go to 4 4 • Orient CSM for solar heating and/or incr elec loads 5 (3) ECS RAD SEC OUT TEMP IND FAILURE 6 ONE OR BOTH HTR FAILED → 7 7 • RAD SEC HTR - SEC (if one htr is operating) → 4	(1) Assumes secondary loop is in operation. Sensor is powered by cb ECS RAD CONT/HTRS MNA (MDC-5). (2) Heater operation can be confirmed by ammeter change during switching operation. Δ current will be: 30 amp - both operating 15 amp - one operating (3) Use SEC GLY EVAP OUT TEMP indicator with ECS RAD SEC IN TEMP indicator to estimate secondary radiator outlet temperature.
25 (1) SEC GLY ACCUM QTY HIGH >55%	*Warning*: If sec accum qty ≥100%, shut RAD SEC HTR - OFF before troubleshooting 1 (2) • SEC COOL PUMP - off (ctr) (momentarily). Gly disch sec press compatible with gly accum qty? — YES: go to 2; NO: go to 4 2 • RAD SEC HTR - OFF. Accum qty decr? — YES: go to 5; NO: go to 3 3 • RAD SEC HTR - SEC • Attempt reduction of sec qty by reducing sec gly loop temp. 4 SEC GLY ACCUM QTY INST FAILURE 5 LOCALIZED BOILING BY RAD HTR → 6 6 Monitor sec ECS gly system for other indications of flow restrictions. If restriction is indicated, bypass radiators.	(1) Normal range 30-55%. (2) With glycol pump off, glycol discharge press should equal 1/4 accumulator quantity.
26 (1) SEC GLY ACCUM QTY DECREASING	1 (2) Sensor check • SEC COOL PUMP - off (ctr) (momentarily). Gly disch sec press compatible for indicated gly accum qty? — YES: go to 2; NO: go to 5 2 Isolate possible leaks • RAD SEC HTR - OFF • GLY TO RAD SEC vlv - BYPASS • SUIT HT EXCH SEC GLY - BYPASS. NOTE: Bypass operation >15 min can lead to rad freezing. Gly accum qty stabilized? — YES: go to 3; NO: go to 9 3 Reactivate rad • RAD SEC HTR - SEC (if reqd) • GLY TO RAD SEC vlv - NORM. Gly accum qty stabilized? — YES: go to 6; NO: go to 4 4 RADIATOR SYSTEM LEAKING → 7 5 GLY ACCUM QTY INST FAILURE → 8 6 SUIT HT EXCH LEAKING → 10 7 Isolate rad • RAD SEC HTR - OFF • GLY TO RAD SEC vlv - BYPASS • Reduce CSM elec loads 8 (4) Reactivate • SEC COOL PUMP - AC1 or (AC2) (if reqd) • RAD SEC HTR - SEC (if reqd) • GLY TO RAD SEC vlv - NORM • SUIT HT EXCH SEC GLY - FLOW 9 LEAKING SYSTEM (CANNOT BE ISOLATED) → 8 10 (3) NOTE: Keep suit ht exch isolated unless required. Check CO_2 filters periodically for seizure.	(1) This symptom is also valid when secondary glycol loop is not in operation. Accum qty and disch press sensors powered by cb SEC COOL XDUCER (MDC-5). Normal range is 30-55%. (2) With pump off, glycol discharge pressure should equal 1/4 gly accum quantity. (3) Humidity control and suit loop cooling not available from secondary loop when suit ht exch is bypassed. A glycol leak will exist whenever the secondary suit ht exch is used and could result in glycol contamination in the suit loop. (4) If leak is determined, temporary deactivation of pump may conserve glycol for future use. Radiator heater to be OFF when pump is OFF.

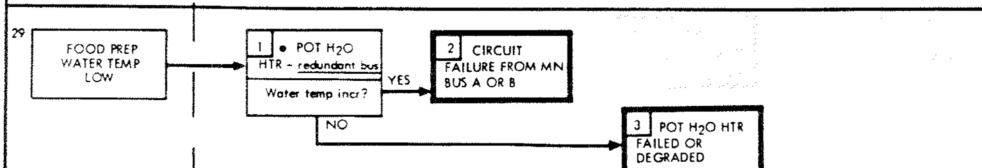
SYMPTOM	PROCEDURE	REMARKS



1. Disch press and accum qty sensor powered by cb ECS SEC COOL XDUCERS (2) (MDC-5).
2. With glycol pump off, glycol discharge pressure should equal 1/4 accumulator quantity.



1. Ice particles visible through windows with no manual dump scheduled. MSFN can also verify by H_2O dump nozzle temp.
2. Yellow QD disconnected to gain access to QD at H_2O OUT connector.
3. Dump flow will taper off rather than stop suddenly if leaking separator is bypassed. If dumping does not stop, reconnect QDs to original connections.
4. Incoming fuel cell water will still pass through this leak.
5. This failure is not serious and will result in approximately equal quantities being maintained in potable and waste water tanks.
6. Prim & sec evap unusable. Water evaporators can be used by periodically opening the waste tank inlet valve for approximately 2-3 minutes until the evaporator wicks are saturated. Water line leakage will occur during these periods.
7. Monitor cabin humidity. Check for water in CM.



ECS MALFUNCTION

SM2A-1663J

SYMPTOM	PROCEDURE	REMARKS
30 ENTRAPPED GAS IN POTABLE H_2O	1 Pot qty full? YES → 2 Isolate pot tk • POT TK IN vlv - CLOSE • H_2O QTY IND sw - POT • Draw off 1 qt H_2O (water gun) Pot qty decr 5%? YES → 4 GAS IS HYDROGEN (2); NO → 3 GAS IS OXYGEN FROM PRESS SYSTEM (1). 1 NO → 4 GAS IS HYDROGEN (2)	(1) System is usable. Quantity gaging capability is compromised. (2) If suited, purge suit periodically.
31 URINE OVERBOARD DUMP NOT DRAINING	1 • Replace urine filter Urine backs up? YES → 2 • Use other collection device Urine backs up? YES → 3 (1) • Orient CSM to heat ovbd dump nozzle • URINE DUMP - redundant htr Urine ovbd drain flow resumes? YES → 4 URINE HEATER FAILURE; NO → 7 BLOCKED URINE OVBD DRAIN (3) → 8 (4) Use waste H_2O vent line • Remove waste H_2O ovbd dump line Q-D cap and stow. • Remove flex hose from Q-D • Connect flex hose to waste H_2O vent line. 1 NO → 5 PLUGGED URINE FILTER. 2 NO → 6 URA OR UTS DEVICE BLOCKED (2)	(1) Allow 2 hrs for heater operation. Orient CSM for maximum external heat on dump nozzle (-Y -Z) in attempt to clear probable ice block. (2) Spare UTS receiver assy stowed in R-11. (3) Water tanks H_2 and O_2 bleed capability lost unless waste H_2O dump line interconnected. (4) Auxiliary dump capability through side hatch is also available. (5) Battery vent capability lost unless urine dump line interconnected
31a WASTE H_2O OVERBOARD DUMP NOT DRAINING	9 (1) • Orient CSM to heat ovbd dump nozzle • WASTE H_2O DUMP - redundant htr Water drains? NO → 10 (5) BLOCKED WASTE H_2O DUMP NOZZLE → 11 (3) Use urine dump line • Remove waste H_2O ovbd dump line Q-D cap and stow. • Remove flex hose from Q-D • Connect flex hose to waste H_2O dump line with spare filter in between. 9 YES → 12 WASTE H_2O DUMP HTR FAILED	
32 INADEQUATE VENTILATION AFTER LANDING	1 Cycle PL vent sw Ventilation incr? YES → 4 (1) Resets attitude sensor relay to resume PLV operation; NO → 2 Actuate PLVC • PLVC sw - OPEN Ventilation incr? YES → 3 ATTITUDE SENSING SW FAILED; NO → 5 (2) PLV FAN FAILURE	(1) Postlanding vent switch must be cycled to OFF and back to HIGH (LOW) anytime CM attitude exceeds 60° to reset attitude control relay. (2) Ventilation available only by opening either hatch.
33 WATER INFLOW AFTER LANDING	1 • PLVC sw - NORM Water inflow stops? YES → 4 Inflow caused by open PLV vlv; NO → 2 • PL VENT - OFF • CAB PRESS RELF vlv (2) - CLOSE Water inflow stops? YES → 5 ATTITUDE SENSING SWITCH FAILED OPEN; NO → 3 UNCONTROLLABLE WATER INFLOW INTO CM	

SM-2A-2258

SPECIAL SUB ROUTINES	PROCEDURE	REMARKS

SSR-1 SECONDARY LOOP ACTIVATION

1 Simultaneous prim and sec loop operation desired?
YES → Caution; NO → 3

Caution (1) (2)
For simultaneous cool loop operation only rad of one cool loop should be used. For loop bypassing rad:
- PRIM/(SEC) GLY TO RAD vlv - BYPASS
- PRIM/(SEC) RAD HTR - OFF

3 Deactivate prim loop (3)
- PRIM EVAP H_2O CONT vlv - OFF
- ECS RAD PRIM HTR - off (ctr)
- GLY EVAP STM PRESS AUTO - MAN
- GLY EVAP STM INCR - INCR for 58 sec
- GLY PUMPS - OFF

2 Activate sec loop
- ECS IND sel - SEC
- GLY TO RAD SEC vlv - NORM (rad open)
- SEC COOL PUMP - AC1 (or AC2)
- SEC GLY DISCH PRESS ind - > 39 psi
- RAD SEC HTR - SEC (rad open)
- SEC EVAP H_2O CONT vlv - AUTO
- SEC COOL EVAP - EVAP
- SEC GLY EVAP OUT TEMP ind - 40-50.5°F
- SUIT HT EXCH SEC GLY vlv - FLOW (if reqd)

4 If a return to prim operation is desired, proceed as follows:

5 Deactivate sec loop
- RAD SEC HTR - OFF
- SEC COOL EVAP - RESET for 58 sec then off (ctr)
- SEC COOL PUMP - off (ctr)
- SEC EVAP H_2O CONT vlv - OFF

6 Activate prim loop
- ECS IND sel - PRIM
- PRIM GLY TO RAD vlv - NORM
- GLY PUMPS - 1 AC1
- PRIM GLY DISCH PRESS ind - >40 psi
- RAD PRIM HTR - 1
- GLY EVAP IN TEMP - AUTO
- PRIM EVAP H_2O CONT vlv - AUTO
- GLY EVAP STM PRESS AUTO - AUTO
- PRIM GLY EVAP OUT TEMP ind - 40-50°F
- SUIT CKT HT EXH - ON for 30 secs then off (ctr)
- CAB TEMP - AUTO

Remarks

(1) If one panel of the primary radiator is lost, the secondary radiator should be used, otherwise the secondary radiator will be lost due to freezing.

(2) Operation of both coolant loops simultaneously may result in low rad out temp. To preclude rad freezing, terminate evap operation if possible.

(3) G&N, DSE, and Signal Conditioners are not coldplated on secondary loop. Usage limits for this equipment are as follows:

G&N 17% duty cycle with max on time of 1 hr 55 min.

DSE 66% duty cycle with max on time of 2 hrs.

SSR-2 FROZEN STEAM DUCT

1 Initiate manual operation
- Orient steam vent outlet to sun (-Y, -Z)
- GLY EVAP STM AUTO - MAN
- GLY EVAP STM INCR - INCR (58 sec)
- GLY EVAP IN TEMP - MAN
- GLY EVAP H_2O FLOW - off (ctr)
- GLY EVAP IN TEMP vlv - adjust (to obtain prim evap out temp ~60°)
- GLY EVAP STM INCR - DECR (6-7 sec)

ECS rad prim out temp < -30°F?
YES → 4; NO → 2

4 Activate sec coolant loop (1)
- SEC COOL EVAP - off (ctr)
- SEC COOL PUMP - AC1 or AC2
- RAD SEC HTR - SEC
- RAD PRIM HTR - off (ctr)
- PRIM GLY TO RAD - BYPASS (pull)

2 Stm press changes (decr) from stabilized value within 15 min?
YES → 3; NO → 5

3 Service evap when stm press > 0.14 psi.
- GLY EVAP H_2O FLOW - ON (2 min) then off (ctr)

Gly evap temp out < 47°F
YES → 6; NO → 5

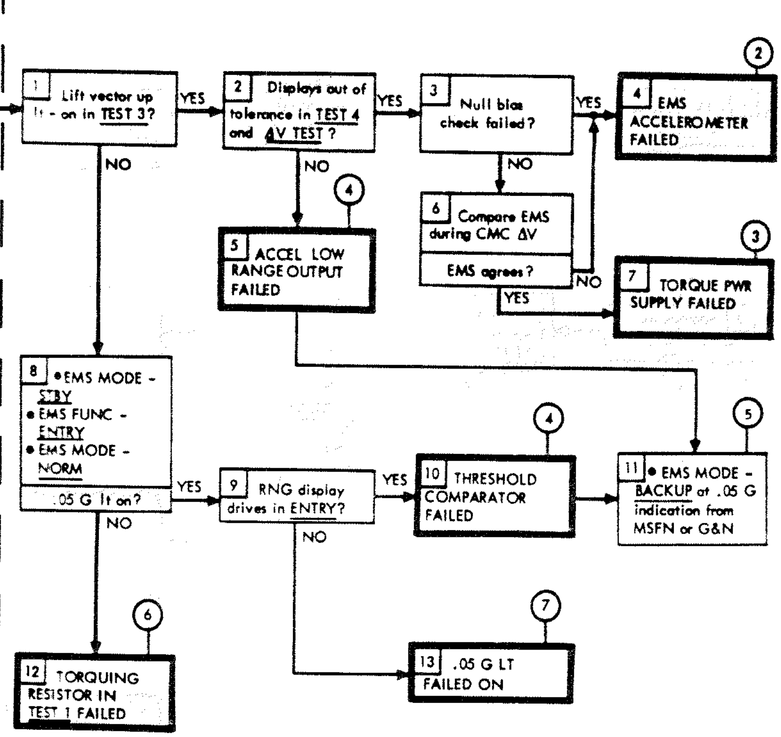
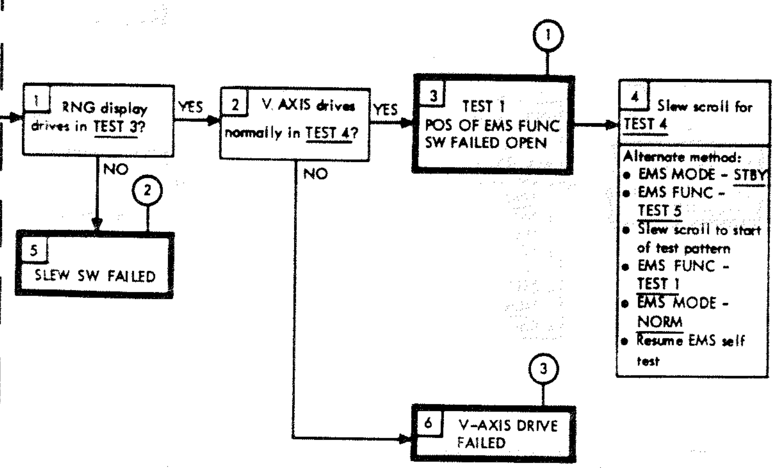
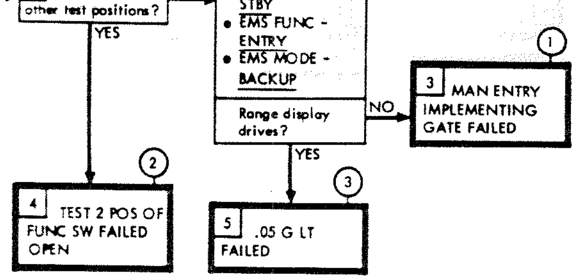
5 Cycle H_2O
- GLY EVAP H_2O FLOW - ON 1 min - off (ctr) 15 min

Gly evap temp out < 47°F
YES → 6; NO → 5

6 Resume norm opr
- GLY EVAP STM PRESS AUTO - AUTO
- GLY EVAP H_2O FLOW - AUTO
- GLY EVAP IN TEMP - AUTO
- PRIM GLY TO RAD vlv - NORM
- RAD PRIM HTR - PRIM 1
- RAD SEC HTR - OFF
- SEC COOL PUMP - off (ctr)

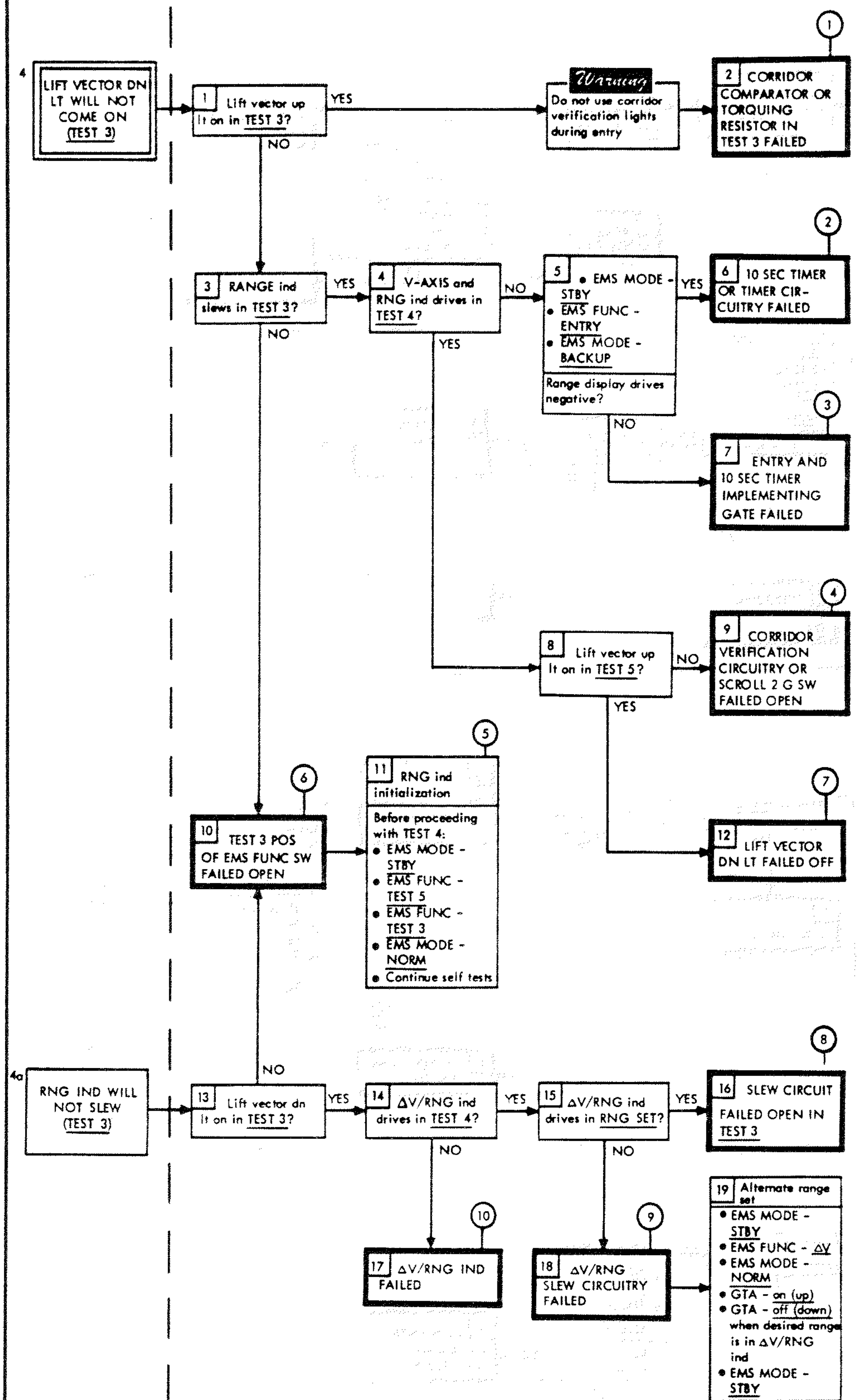
Remarks

(1) Primary glycol evaporator temperature inlet can be approximated by secondary radiator inlet temperature.

SYMPTOM	PROCEDURE	REMARKS
1 .05G LT ON (TEST 1)		(1) The EMS MODE sw assumed to be in STBY for at least 5 sec before self-test started. (2) EMS lost except EMS RSI. (3) All self test capability lost. For entry, G-Drive, and corridor verification will be erroneous. ΔV/RNG ind, V AXIS and EMS RSI unaffected. (4) AUTO position functions of EMS MODE sw lost for entry only. (5) Corridor verification inoperative with EMS MODE sw - BACKUP. (6) EMS FUNC - TEST 1 lost only. (7) Loss of threshold cue only (.05 G lt). RNG ind operation is indication of .05 G.
2 G/V SCROLL ASSY DOES NOT SLEW (TEST 1)		(1) EMS FUNC - TEST 1 capability lost only. (2) RNG SET capability lost. SCS ΔV possible only if ΔV display is driven positive by placing the GTA sw - on (up), then - off (down) at the desired value. G&N or ΔV maneuver with the SPS THRUST - DIR ON can be monitored by the change in the ΔV display (down to -9999 fps). Vo can be set by using EMS FUNC - TEST 4 (repeatedly if necessary), stopping the V drive at the desired value by EMS FUNC - TEST 5. No backup capability available. (3) EMS lost for ENTRY except threshold, corridor, and EMS RSI. ΔV functions unaffected.
3 .05 G LT OUT (TEST 2)		(1) ENTRY functions of EMS inoperative except EMS RSI. ΔV functions unaffected. (2) EMS FUNC - TEST 2 inoperative. (3) EMS operation unaffected. RNG ind operation is indication of .05 G.

SM-2A-1557E

SYMPTOM	PROCEDURE	REMARKS



REMARKS

(1) There is no method of distinguishing between these failures.

(2) Corridor verification, ΔV TEST, TEST 3, TEST 4, and TEST 5 inoperative. EMS operational during entry, but accelerometer accuracy can be verified for confidence by comparison with a CMC ΔV.

(3) ENTRY functions of EMS inoperative except EMS RSI ΔV functions unaffected.

(4) Corridor verification lts inoperative or invalid during TEST and ENTRY.

(5) This step assures initialization of the range integrator for TEST 4.

(6) TEST 3 lost. RNG ind may be tested in TEST 4 by noting that the RNG ind drives to negative 58.0 ± .2 NM.

(7) Lift vector dn lt lost in TEST 3 and ENTRY. Backup ENTRY information from CMC or MSFN. No lt 10 sec after .05 G could be used to indicate lift vector down.

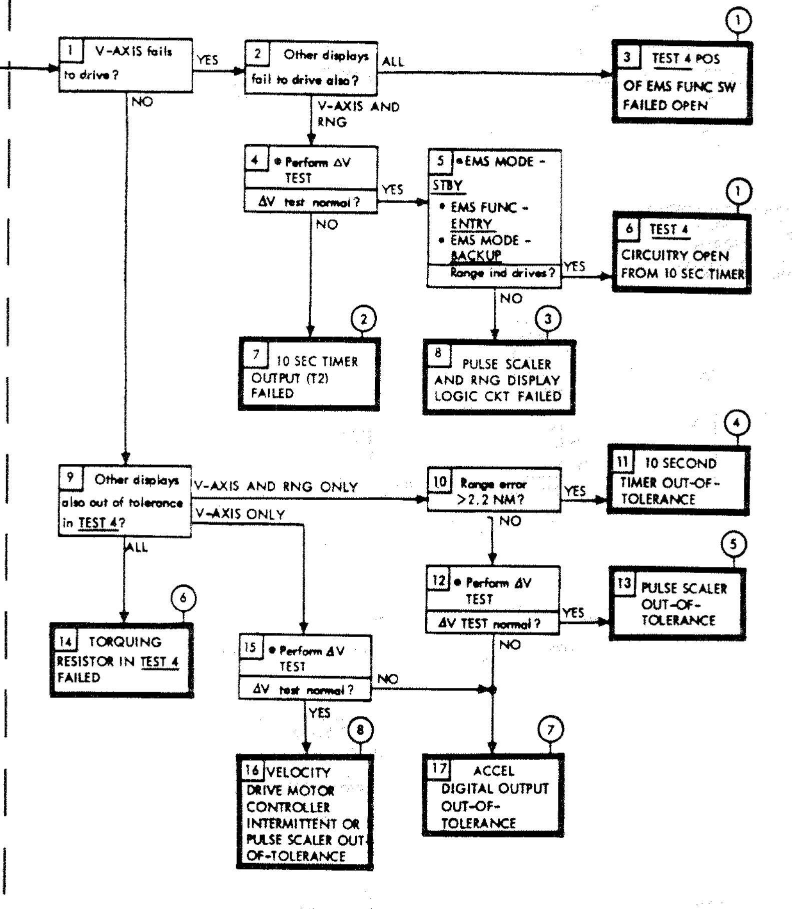
(8) EMS operation unaffected.

(9) Normal RNG SET method lost.

(10) ΔV/RNG ind lost.

SYMPTOM	PROCEDURE	REMARKS

5 V-AXIS ONLY OR MULTIPLE DISPLAYS ABNORMAL (TEST 4)



(1) EMS FUNC - TEST 4 capability lost. EMS operational but accelerometer accuracy can be verified only by performing a ΔV TEST.

(2) TEST 4 and ΔV TEST only lost.

(3) V-axis and range display lost.

(4) This failure will invalidate the ΔV TEST and TEST 4, except the G-axis display. EMS should be operational but corridor verification erroneous during entry.

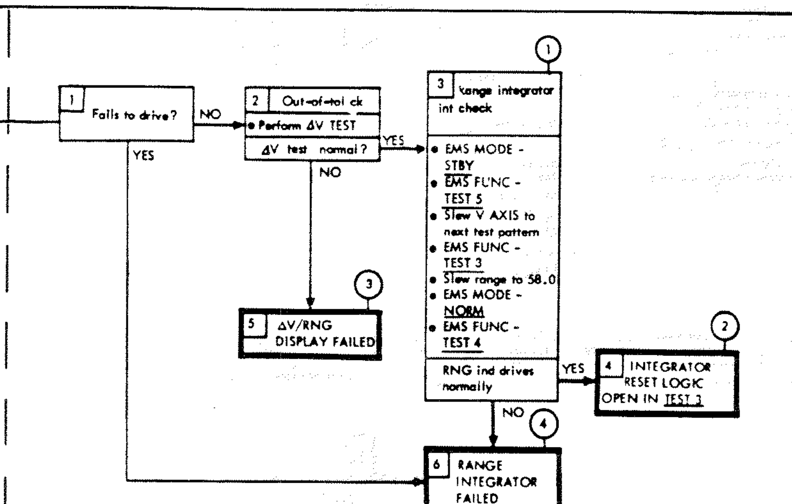
(5) V AXIS and RNG information erroneous only.

(6) EMS FUNC - TEST 4 lost but EMS operation during entry should be normal.

(7) V AXIS, ΔV and RNG information erroneous. Other EMS information unaffected. MSFN may be able to supply a correction factor for this error.

(8) There is no method of distinguishing between these two failures. Scroll velocity information will be erroneous. Range readout of uncertain validity.

6 RNG IND ONLY ABNORMAL (TEST 4)



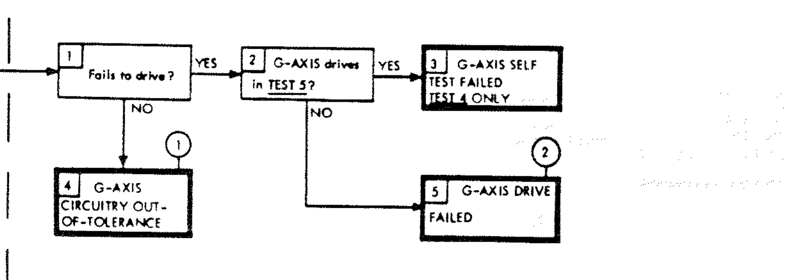
(1) This check constrained by test pattern availability.

(2) EMS ENTRY and ΔV functions unaffected.

(3) RNG and ΔV displays lost.

(4) RNG display lost.

7 G-AXIS ONLY ABNORMAL (TEST 4)



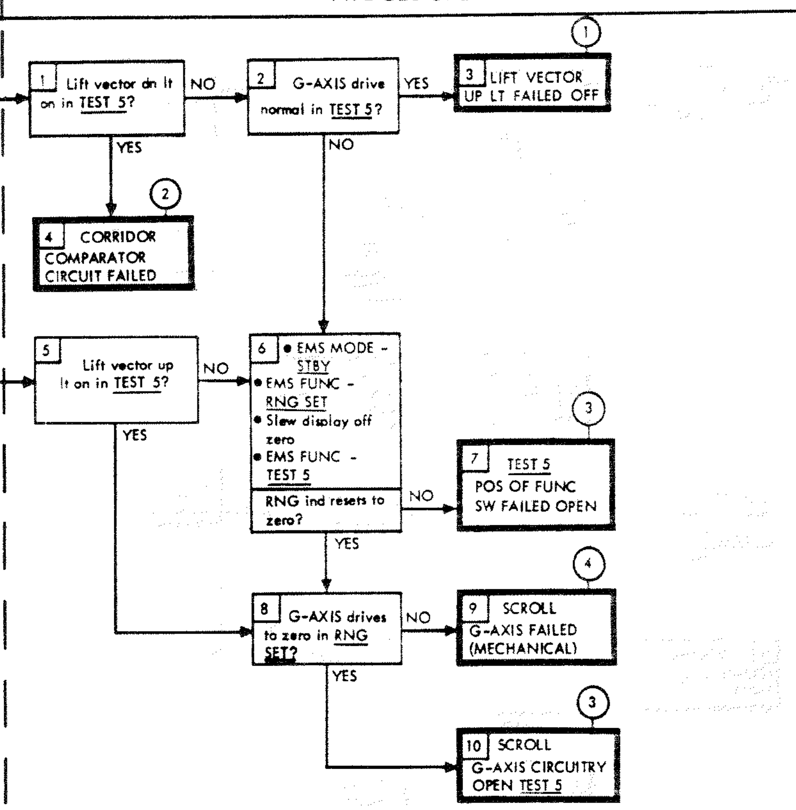
(1) Scroll G display erroneous.

(2) Scroll G display lost. Backup G information from CMC or G meter.

SYMPTOM	PROCEDURE	REMARKS

8 LIFT VECTOR UP LT NOT ON (TEST 5)

8a G-AXIS DOES NOT DRIVE (TEST 5)

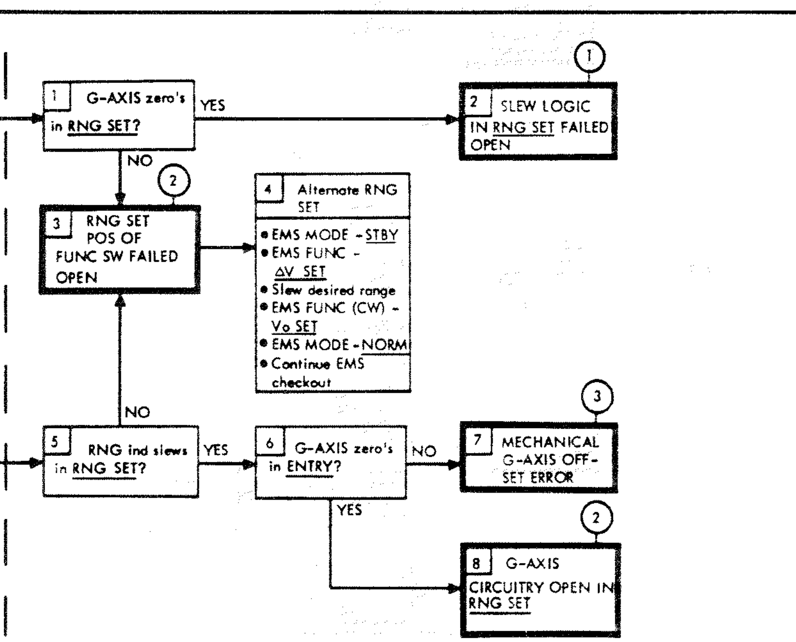


Remarks:

1. Lift vector up lt lost in TEST 5 and ENTRY. Backup entry angle information from CMC or MSFN. No lt 10 sec after .05 G could be used to indicate lift vector up.
2. Corridor verification lost during TEST 5 and ENTRY. Backup entry angle information from MSFN or CMC.
3. EMS FUNC - TEST 5 lost only.
4. Scroll G display inoperative.

9 RNG IND DOES NOT SLEW IN RNG SET

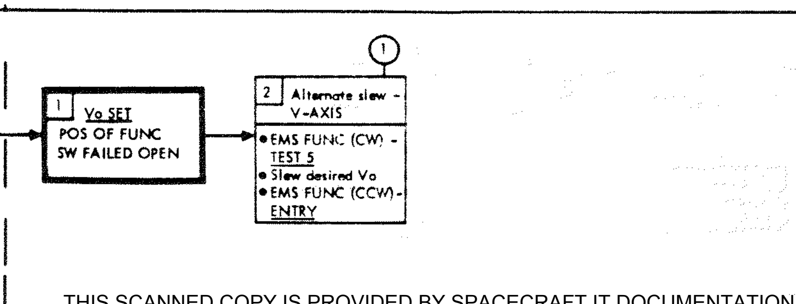
9a G-AXIS DOES NOT ZERO IN RNG SET



Remarks:

1. EMS operation unaffected. Use alternate RNG SET method.
2. ENTRY operation unaffected.
3. This failure produces an error only in the initial phase of the G trace.

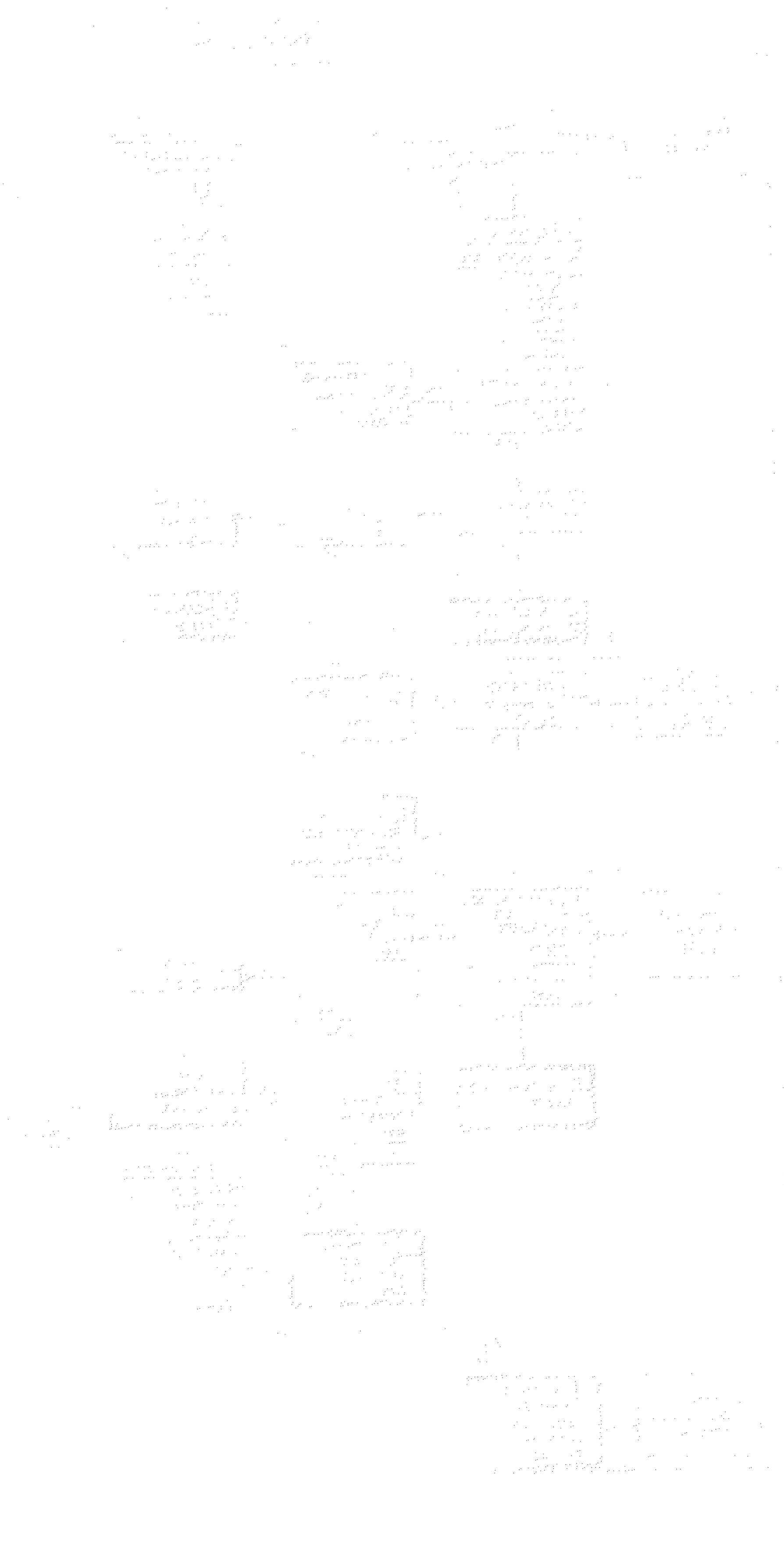
10 V-AXIS DOES NOT SLEW IN Vo SET



Remarks:

1. Range display erroneous during ENTRY. Other ENTRY functions unaffected after Vo slewed by alternate methods.

	SYMPTOM	PROCEDURE	REMARKS
11	ΔV/RNG IND ABNORMAL IN ΔV TEST	1 Problem? FAILS TO DRIVE → 2; OUT OF TOLERANCE → 4 2 ENTRY self test (1): • EMS MODE - STBY • EMS FUNC - TEST 1 • EMS MODE - NORM • Perform ENTRY self test. ΔV/RNG Ind drives TEST 4? NO → 3; YES → 6 3 ΔV/RNG DISPLAY FAILED (2) 4 ENTRY self test (1): • EMS MODE - STBY • EMS FUNC - TEST 1 • EMS MODE - NORM • Perform ENTRY self test. V-AXIS and RNG within tolerance in TEST 4? YES → 5; NO → 7 5 TORQUING RESISTOR FAILED IN ΔV TEST (3) 6 ΔV TEST POSITION OF FUNC SW FAILED OPEN (3) 7 RANGE error >2.2 NM? NO → 8; YES → 10 8 Monitor CMC ΔV. EMS agrees? YES → 9; NO → 11 9 ACCELEROMETER TORQUER PWR SUPPLY FAILED (4) 10 10 SEC TIMER OUT OF TOLERANCE (5) 11 ACCELEROMETER FAILED (6)	(1) ENTRY TEST patterns constrain option of ENTRY self test. (2) ΔV/RNG Ind lost for ΔV maneuver and ENTRY. (3) ΔV TEST only lost. (4) EMS RSI, V-AXIS and RNG displays unaffected during ENTRY, ΔV, G-AXIS and corridor verification lost. (5) All ΔV, EMS velocity and RNG information erroneous during test modes. EMS should be operational, but corridor verification erroneous during ENTRY. (6) EMS RSI unaffected. All other EMS functions lost.
12	SPS THRUST LT NOT ON IN ΔV TEST	1 SPS THRUST lt on during SPS firing? NO → 2; YES → 3 2 SPS THRUST LT FAILED OFF 3 SPS THRUST ON CIRCUITRY FAILED IN ΔV TEST (1)	(1) THRUST ON signal lost in ΔV TEST only.
13	ΔV IND DOES NOT SLEW IN ΔV SET	1 • EMS FUNC - ΔV TEST • EMS MODE - NORM. ΔV ind drives negative? YES → 2; NO → 4 2 • EMS MODE - STBY • EMS FUNC - TEST 5 • Attempt scroll slew. V-AXIS slews? NO → 3; YES → 5 3 SLEW SW FAILED (1) → 7 4 ΔV/RNG IND FAILED (2) 5 • EMS FUNC - RNG SET • Attempt range slew. RNG ind slews? NO → 6; YES → 8 6 ΔV/RNG SLEW CIRCUITRY FAILED OPEN (1) → 7 7 Alternate ΔV SET: • EMS MODE - STBY • EMS FUNC - ΔV • EMS MODE - NORM • GTA - on (up) • EMS MODE - STBY. When desired ΔV SET in display • GTA - off (down) 8 ΔV POSITION OF FUNC SW FAILED OPEN (3) → 9 9 Alternate ΔV SET: • EMS MODE - STBY • EMS FUNC - RNG SET • Slew desired ΔV • EMS FUNC (CCW) - ΔV • EMS MODE - NORM	(1) Alternate ΔV SET necessary for SCS ΔV's. For CMC or MANUAL ΔV's (DIRECT THRUST sw), monitor the negatively driven ΔV ind for velocity change information. (2) ΔV/RNG ind lost. (3) Slew lost for ΔV SET only.
14	ΔV/RNG IND FAILS TO COUNT DURING ΔV'S	1 ΔV POS OF FUNC SW FAILED OPEN (MOST PROBABLE FAILURE) (1)	(1) Thrust cutoff discrete and ΔV functions of ΔV/RNG ind lost. Performing a post-burn ΔV TEST and/or ENTRY test will aid in failure identification.
15	EITHER LIFT VECTOR LT ON AFTER 2 G	1 2G SW FAILED (1)	(1) EMS functions unaffected.



SYMPTOM	PROCEDURE	REMARKS

DOCKING

1 DOCK PROBE WILL NOT FOLD

1 LM manned? — YES: go to 2; NO: go to 3

2
- Remove drogue from LM side
- Connect probe umbilicals (2) (yellow)
- Cb DOCK PROBE (2) - close
- Verify LM tunnel hatch open and crew clear of tunnel
- PROBE EXTD/REL - EXTD/REL for 20 sec. max.
- Verify probe extension
- Cb DOCK PROBE (2) - open
- Using tools F, W and 1, remove nut and bolt from one end of shock struts (3)
- Fold support beams by pulling probe toward CSM
- Disconnect probe umbilicals (2) (yellow) and remove probe from tunnel

3
- Verify probe support beams unloaded
- Using tools F, W and 1, remove nut and bolt from one end of shock struts (3)
- Connect probe umbilicals (2) (yellow)
- Cock docking latches No. 1 & 3
- Cb DOCK PROBE (2) - closed
- Cb SECS ARM (2) - closed
- After MSFN AOS, SECS LOGIC (both) - on (up)
- After go from MSFN, SECS PYRO ARM (2) - on (up)
- PROBE EXTD/REL - RETRACT
- PROBE RETRACT SEC - 1
- PROBE RETRACT (2) - off
- SECS PYRO ARM (2) - off
- SECS LOGIC (both) - off
- Cb SECS ARM (2) - open
- Manually release docking latches 1 & 3
- Preload the probe
- PROBE EXTD/REL - EXTD/REL for 20 sec. max.
- Verify extend latch indicator (red) is visible
- Depress probe BLEED button (red) at intervals to allow probe to extend slowly
- PROBE EXTD/REL - EXTD/REL and hold
- Pull probe aft (20 lb) to release from drogue
- PROBE EXTD/REL - OFF (release)
- Cb DOCK PROBE (2) - open
- Disconnect probe umbilicals (2) (yellow) and remove probe from tunnel

2 DOCK PROBE EXTD/REL tb A(B) REMAINS GRAY AFTER CAPTURE (TLD only)

1 Attempt retraction
- PROBE EXTD/REL - RETR
- PROBE RETR - PRIM 1 (SEC 1)

Retraction? — YES: go to 5; NO: go to 2

2
- PROBE RETR - PRIM 2 (SEC 2)

Retraction? — YES: go to 6; NO: go to 3

3
- PROBE RETR - SEC-1 (PRIM-1)

Go to 4

4 Troubleshoot System A(B) before removing probe as follows
- PROBE RETR (2) - OFF
- cb DOCK PROBE (2) - open
- Interchange probe umbilical connectors (cut cable retainers if necessary)
- Cock docking latches 1 and 7
- cb DOCK PROBE (2) - close
- PROBE EXTD/REL - RETR

DOCK PROBE EXTD/REL tb B(A) - gray? — YES: go to 7; NO: go to 9

5 tb OR tb CIRCUIT FAILURE

6 PYRO OR GN2 BOTTLE FAILURE

7 SYSTEM A (B) CIRCUIT FAILURE IN PROBE — go to 8

8
- Interchange umbilicals again
- Use SEC 2 (PRIM 2) to initiate only available GN_2 bottle when required
- Manually release docking latches No.'s 1 and 7

9 SYSTEM A (B) CIRCUIT FAILURE IN CSM — go to 10

10
- Use SEC-1 (PRIM 1) and SEC-2 (PRIM 2) to initiate two available GN2 bottles when required.
- Manually release docking latches No.'s 1 and 7

SM-2A-1746H

SYMPTOM	PROCEDURE	REMARKS
HATCH 1 FWD HATCH WILL NOT UNLATCH	1 Does actr handle drive clutch engage gearbox? NO → 2; YES → 3 2 Assume failure of actr handle to engage and drive gearbox → 4 3 Assume failure is frozen gearbox. → 5 4 • Unstow actr handle and push to stop to unlock gearbox • AUX LATCH DRIVE - <u>rotate 113°</u> (use tool B) • Remove tool B and verify hatch unlatch 5 • Remove gearbox mounting screws (3) and spacers (use tools W and 4) • Unstow actr handle and rotate away from hatch approx 30° • Push actr handle outboard rotating gearbox approx 40° CCW to release latches • Remove hatch from tunnel → 6 6 To reinstall hatch • Align hatch in tunnel • Rotate gearbox approx 40° CW and reinstall gearbox mounting screws (3)	
2 FWD HATCH WILL NOT LATCH	1 • Remove hatch to CM cabin • Attempt to latch mechanism Does actr handle drive gearbox? NO → 2; YES → 3 2 Gearbox frozen • Gearbox disconnect - <u>180° CCW</u> (tool B) • Position hatch in tunnel • AUX LATCH DRIVE - LATCH (113° CW - tool B) • Verify hatch latched, remove tool B (cannot remove hatch from LM side) 3 Frozen latch • Inspect to identify frozen latch(es) • Remove dome nuts from long pivot screws of frozen latch. (Use tools F, W, 2 and 4) • Remove long pivot screws and rotate latch dog to clear striker plate • Unlatch mechanism • Install hatch	

STA/T	STEP	PROCEDURE	PANEL	REMARKS

5.3 EMERGENCY PROCEDURES

INTRODUCTION

Emergency procedures provide the crew with the necessary steps to quickly alleviate situations that have (or will) become both crew-hazardous and time-critical. These procedures require instant reaction on the part of the crew to prevent the conditions from becoming worse. In most instances the conditions are physically sensed by the crew rather than brought to their attention by the caution and warning system or voice communication from MSFN.

5.3.1 PAD EMERGENCY PROCEDURES

5.3.1.1 Rapid Hatch Opening

STA/T	STEP	PROCEDURE	PANEL	REMARKS
				To accomplish rapid hatch opening after engaging latches, the hatch must be configured for rapid egress as shown in 4.2.1 (step 6), Cabin Closeout.
CMP	1	Gear box sel - UNLATCH (verify)	Side hatch	
	2	Actr handle rel - push or squeeze		
	3	Actr handle - opr (until hatch is unlatched)		Lock pin will be sheared. About 5 cycles of actuator operation will open hatch.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx If hatch fails to open GN2 ratchet handle - opr GN2 vlv handle - unlock & push (outbd) xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		5.3.2 FLIGHT EMERGENCY PROCEDURES		
		5.3.2.1 Fire/Smoke in CM During Boost		
LMP	1	CAB FAN (both) - OFF (verify)	2	
	2	Mon EPS inds for excess current. Immediately remove pwr from affected bus to prevent further damage to critical sys		
	3	If in abort mode I or II SUIT COMPR 1 (or 2) - on good ac bus	4	
	4	If in abort mode III & affected bus is MNA (or B)		
CDR		TVC GMBL DR (2) - 2 (or 1)	1	
LMP		INV 1 (or 2) AC1 (or 2) - OFF	3	
		INV 2 (or 1) AC1 (or 2) - on (up)		Powers both ac buses with inverter from good main bus.
CDR	5	rh CAB PRESS RELF vlv - DUMP (safety latch off)	325	
	6	Continue appropriate abort		

EMERGENCY PROCEDURES

Basic Date 17 July 1970 Change Date

STA/T STEP	PROCEDURE	PANEL	REMARKS
	5.3.2.2 Fire/Smoke in CM - Orbital Operations		
	a. Suited Crew		
LMP	CAB FAN (both) - OFF (verify)	2	
	Mon EPS inds for excess current. Immediately remove pwr from affected bus to prevent further damage to critical sys		
	SUIT COMPR 1 (or 2) - on good ac bus	4	
	Fire extinguisher - use as appropriate		Water dispenser used on all open nonelectrical fires. Foam fire extinguisher used on fires behind panels, closed compartments, and electrical fires.
	Fire out		
	WARNING Combustion products may be toxic. Smoke should be removed from cab per Contam in CM, 5.3.2.4 (step 3b) before removing helmets.		
	Fire persists		
	Dump cab as follows		
CDR	SUIT RETURN vlv - close (push) (verify)	380	
CMP	EMER CAB PRESS sel - OFF (verify)	351	
CDR	REPRESS PKG vlv - OFF (verify)	326	
ALL	PGA - vis integrity check		

STA/T STEP	PROCEDURE	FANEL	REMARKS
CDR,LMP	rh CAB PRESS RELF vlv - DUMP (safety latch off) until	325	Provides controlled cabin dump until suit circuit pressure verified.
	CAB PRESS ind 3.0 psia, then to BOOST/ENTR	2	
LMP	SUIT PRESS ind - holding >3.5 psia (verify)		
CDR,LMP	rh CAB PRESS RELF vlv - DUMP	325	
	&/or CAB PRESS DUMP vlv - open (CCW)	Side hatch	
LMP	CAB PRESS ind - 0.0 psia for 6 min	2	Time period is a function of equipment oxygen exposure and saturation level.
CDR,LMP	rh CAB PRESS RELF vlv - NORM (safety latch on) &	325	
	CAB PRESS DUMP vlv - close (CW)	Side hatch	
	WARNING Do not repress cab until fire source removed. Reignition may occur with additional damage. If condition lasts longer than 10 min, gly circulation & temp cont must be re-established.		
	b. Unsuited or Partially Suited Crew		
ALL	Don emer O2 mask (refer to Oper of Emer O2 Masks, 4.5.4.15)		
LMP	CAB FAN (both) - OFF (verify)	2	
	SUIT COMPR (both) - OFF	4	

STA/T STEP	PROCEDURE	PANEL	REMARKS
LMP	Mon EPS inds for excess current. Immediately remove pwr from affected bus to prevent further damage to critical sys	3	
	Fire extinguisher - use as appropriate		Water dispenser used on all open nonelectrical fires. Foam fire extinguisher used on fires behind panels, closed compartments, and electrical fires.
	Fire out		
	<u>WARNING</u> Combustion products may be toxic. Smoke should be removed from cab per Contam in CM, 5.3.2.4 (step 3b) before removing helmets.		
	Fire persists		
ALL	Don PGA except helmet (refer to PGA Mode Changes, 4.5.4.6)		02 connections red-to-red and blue-to-blue. Use 02 masks as long as possible.
CDR	DIRECT 02 vlv - OPEN (CCW)	7	Purges suit inlet manifold, suit hoses, and PGA portion of suit circuit.
ALL	Remove emer 02 mask & don helmet		
CMP	SUIT FLOW vlv (3) - FULL FLOW	300,301,302	
LMP	SUIT COMPR 1 (or 2) - AC1 (or AC2)	4	
CDR	DIRECT 02 vlv - close (CW)	7	
CMP	EMER CAB PRESS sel - OFF	351	
ALL	PGA - vis integrity check		
CDR,LMP	rh CAB PRESS RELF vlv - DUMP (safety latch off) until	325	Provides controlled cabin dump until suit circuit pressure is verified.
	CAB PRESS ind 3.0 psia, then to BOOST/ENTR	2	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP		SUIT PRESS ind - holding >3.5 psia (verify)	2	
CDR,LMP		rh CAB PRESS RELF vlv - DUMP &/or CAB PRESS DUMP vlv - open (CCW)	325 Side hatch	
LMP		CAB PRESS ind - 0.0 psia for 6 min	2	Time period is a function of equipment oxygen exposure and saturation level.
CDR,LMP		rh CAB PRESS RELF vlv - NORM (safety latch on) & CAB PRESS DUMP vlv - close (CW)	325 Side hatch	

WARNING

Do not repress cab until fire source removed. Reignition may occur with additional damage. If condition lasts longer than 10 min, gly circulation & temp cont must be re-established.

5.3.2.3 Fire/Smoke in CM During Entry

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP	1	CAB FAN (both) - OFF (verify)	2	
LMP	2	Mon EPS inds for excess current. Immediately remove pwr from affected bus to prevent further damage to critical sys	3	
CDR	3	RHC PWR DIR (both) - MNA/MNB, & maintain att if req	1	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP	4	If affected bus is MNA INV 1 AC1 - OFF INV 2 AC1 - on (up)	3	Powers both ac buses with inverter being powered from good dc main bus, providing ac power for suit compressors and SCS.
CDR		Set up for CM/RCS sys 2 AUTO RCS A/C ROLL (4) - OFF AUTO RCS CM 1 (6) - OFF AUTO RCS CM 2 (6) - MNB	8	System 1 is normal and system 2 is redundant.
		Use only RHCs to dump RCS prplnts, not CM PRPLNT DUMP sw		If CM PRPLNT DUMP switch used with MNA bus failed, all oxidizer not expended.
LMP	5	If affected bus is MNB INV 2 AC2 - OFF INV 1 AC2 - on (up)	3	Powers both ac buses with inverter being powered from good dc main bus, providing ac power for suit compressors and SCS.
		Use only RHCs to dump RCS prplnts, not CM PRPLNT DUMP sw		If CM PRPLNT DUMP switch used with MNB bus failed, all fuel not expended.
CDR	6	rh CAB PRESS RELF vlv - DUMP (safety latch off)	325	
	7	Continue entry		
	5.3.2.4	<u>Contamination in CM</u>		Types, sources, and amount of contamination not defined. The very existence of contamination in CM is treated as an emergency.
ALL	1	Don emer O2 mask &/or PGA immediately (refer to Oper of Emer O2 Masks, 4.5.4.15 & PGA Mode Changes, 4.5.4.6)		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
ALL	2	Evaluate contam level, & isolate or correct source of contam		
	3	If contam persists		
		a. Acpt contam level in cab		Slow removal of contamination accomplished with WASTE STOW valve (panel 252) in VENT position.
		Retain O2 mask or remain in PGA		
CDR,CMP		If in PGA, adj DIRECT O2 vlv for SUIT CAB $\Delta P > 2$ in. H_2O	7,2	
		b. Dump & repress cab		
ALL		Retain or don PGA (refer to PGA Mode Changes, 4.5.4.6) PGA - vis integrity check Perform CM Press Dump, 4.5.4.11 Perform CM Repressurization, 4.5.4.8a		
	5.3.2.5	<u>Contamination in Suit (Suited Crewman)</u>		Contamination originates within suit circuit if, after purging with oxygen, contamination still present.
LMP	1	SUIT COMPR 2 - AC1	4	
	2	SUIT COMPR 1 - OFF		
CDR	3	DIRECT O2 vlv - OPEN (CCW) for 1 min, then close (CW)	7	
	4	If condition persists		
LMP		SUIT COMPR 2 - OFF	4	
CDR		DIRECT O2 vlv - close (CW)	7	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
ALL		Doff helmet		
		Don emer 02 mask (refer to Oper of Emer 02 Masks, 4.5.4.15)		
		Determine contam cause		
	5.3.2.6	<u>LET Fails to Jettison</u>		
	a.	Tower legs cut/no jett mot ign		
CDR		LES MOT FIRE pb - push	1	Guarded.
		If tower jett successful,		
CMP		TWR JETT (both) - OFF (ctr)	2	Guarded.
		Continue mission		
		If tower jett unsuccessful		
		TWR JETT (both) - OFF (ctr)		Guarded.
		Report to MSFN & go for orbit		
	b.	No response to TWR JETT sws		
		Verify the following		
CDR		cb SECS ARM (2) - close	8	
		cb SECS LOGIC (2) - close		
		cb EDS (all) - close		
		SECS LOGIC (both) - on (up)		Lever lock.
		SECS PYRO ARM (2) - on (up)		Lever lock.
		EDS PWR - on (up)	7	
CMP		TWR JETT (both) - on (up)	2	Guarded. On (up) position is momentary.
		If tower jett successful		
		TWR JETT (both) - OFF (ctr)		Guarded.
		Continue mission		
		If tower jett unsuccessful		
		TWR JETT (both) - OFF (ctr)		Guarded.
		Report to MSFN & go for orbit		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		5.3.2.7 <u>Forward Hatch Cannot Be Re-installed</u>		
CMP	1	Position hatch & depress tunl		
		Don PGA, 4.5.4.6, thermal gloves, & check suit ckt, 4.5.4.9		
		CAB PRESS ind - 4.8-5.2 psia (verify)	2	
		02 FLOW ind - 0.4-0.6 lb/hr (verify)		
		Position fwd hatch against tunl hatch seal interface misaligning hatch ind arrows by 30° in either direction		
		While pushing hatch firmly against tunl hatch seal interface		
		TUNL VENT vlv - TUNL VENT	12	
		Wait one min, then place TUNL VENT vlv - LM/CM ΔP		
		Mon LM/CM ΔP ind & verify ΔP ≈2.5 psid. If ΔP ≠2.5 psid, recycle TUNL VENT vlv until ΔP ind is ≈2.5 psid		When LM/CM ΔP ind indicates ≈2.5 psid, hatch should be held immobile against seal by ΔP.
		Continue mon LM/CM ΔP ind for 1 min after reaching ≈2.5 psid & verify no detectable change in ΔP ind		This constitutes a hatch seal integrity check.
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
		LM/CM ΔP ind - press differential decr		
		Mon CAB PRESS ind & 02 FLOW ind	2	
		If CAB PRESS ind & 02 FLOW ind remains stable, LM hatch is probably not integral		If this condition occurs, further action is dependent upon LM documentation.
		If CAB PRESS ind decr & 02 flow ind incr, CM fwd hatch is probably not integral		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CMP		Pressurize tunl using PRESS EQUAL vlv	Fwd hatch	
		Open fwd hatch, 4.5.7.4a		
		Check for foreign object(s) jammed in tunl/hatch, seal interface, or hatch seal damage		
		Reposition fwd hatch against hatch seal interface		
		Reinitiate tunl depress & hatch seal integrity check		
		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		
	2	Perform LM Jettison, 4.10.1.6		
	3	Perform the following ≈1 hr prior to CM/SM sep to raise CM press to max design press of 8.6 psid		
		CAB PRESS RELF vlv (2) - CLOSE	325	
		REPRESS PKG vlv - OFF	326	
		EMER CAB PRESS sel - OFF	351	
		CAB REPRESS vlv - open (CW)		
		REPRESS 02 - CLOSE	601	
		When CAB PRESS ind - 8.6 psia	2	
		CAB REPRESS vlv - OFF (CCW)	351	
		REPRESS PKG vlv - FILL	326	
	4	Begin entry prep, 4.15		
60K'		REPRESS 02 - OPEN	601	Provides an additional 3 psia in ≈1 minute period.
CDR	50K'	Report CM stable		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		CM unstable		
CMP		RCS CMD - OFF	2	OFF position is momentary.
CDR	40K'	APEX COVER JETT pb - push	1	Guarded.
		DROG DPLY pb - push (2 sec after apex cover jett)		Guarded.
	30K'	ELS LOGIC - on (up)		Guarded.
		ELS AUTO - AUTO		
CMP				
	24K'	SCS RCS disable (auto)		
		RCS CMD - OFF	2	OFF position is momentary.
		Apex cover jett (auto)		The apex cover will be jettisoned at 24K feet plus 0.4 second.
CDR		APEX COVER JETT pb - push	1	Guarded.
		Drogue chutes deployed (auto)		Drogue parachutes deployed at 24K feet plus 2.0 seconds. CM may be very unstable until drogue chutes disreef in ≈11 seconds.

STA/T STEP	PROCEDURE	PANEL	REMARKS
CDR	xxxxxxxxxxxxxxxxxxxxxxx DROG DPLY pb - push xxxxxxxxxxxxxxxxxxxxxxx	1	Guarded.
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx If no drogue deploy ELS AUTO - MAN Stab CM with direct RCS 5K' MN DPLY pb - push ELS AUTO - AUTO xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx		Guarded.
10K'	Main chutes & VHF recovery ant deploy (auto)		Auto deployment occurs between 10,950 and 9,100 feet. Parachutes disreef in ≈15 seconds after pilot mortars fire.
	MN DPLY pb - push (within 1 sec)		Guarded. MN DPLY pushbutton should be pushed within one second after pilot mortars fire to ensure simultaneous deployment of main parachutes.
10K' +20 sec	Immediately following mn chute disreefing, CMP must egress from ctr couch & position himself in an optimum stance to support fwd hatch (≈85 lbs) When CMP in position CAB PRESS DUMP vlv - open (CCW) (full open)	Side hatch	
CMP	As press equalization allows fwd hatch to move, retrieve hatch & stow in hatch stowage bag		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		CAUTION Care must be exercised in handling fwd hatch because it will be at a high temp.		
CDR		CAB PRESS DUMP vlv - close (CW)	Side hatch	
LMP		Set up entry comm		
		VHF ANT - RECY	3	
		VHF AM A - SIMPLEX		If VHF AM B SIMPLEX or VHF AM A DUPLEX is required, turn off beacon during period of transmission.
		VHF BCN - ON		
CDR		Xmit voice (VHF AM) reporting Position Mn chutes disreefed Splash err Crew stat		Continue voice transmission until touchdown.
		Crew couch struts (4) - unlock		
		WARNING RCS prplnts should not be purged because of open hatch.		
LMP		cb FLT/PL BAT BUS A, B, & BAT C (3) - close	275	
		cb FLT/PL MNA - open		
		cb FLT/PL MNB - open		
		cb RAD HTRS OVLD (2) - open	5	
CDR		cb SPS PITCH (2) - open	8	
		cb SPS YAW (2) - open		

STA/T STEP	PROCEDURE	PANEL	REMARKS
3K' CDR	FLOOD FIXED - POST LDG	8	Provides power from flight and postlanding bus to one floodlight in LH couch area and one floodlight in center couch area. Minimize floodlight use during postlanding. Maximum utilization should be 9.6 hours per 48-hour period.
	FLOOD DIM - 1 or 2		Position 1 provides power to two secondary floodlights and position 2 provides power to two primary floodlights when FLOOD LTS FIXED switch in POST LDG position after dc main buses deactivated.
1000' CMP	CM RCS PRPLNT (both) - OFF	2	OFF position is momentary.
	CM RCS PRPLNT tb (both) - bp		Barber pole indicates at least one propellant isolation valve (fuel or oxidizer) closed in particular system 1 or 2.
CDR	DIRECT O2 vlv - OPEN (CCW)	7	
LMP	MN BUS TIE (2) - OFF	5	Removes battery power from dc main buses A and B.
	CAUTION MN BUS TIE sw (2) must be left in OFF position to ensure bats A, B, & C are used to pwr postlanding bus only, & to prevent bat shorting caused by water entering CM feed-thru conns.		
	cb BAT RLY BUS (2) - open		
	Postlanding Check, 4.17		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	5.3.2.8	<u>Emergency Safe of Apex Cover Jett</u>		
		If no MSFN GO for pyro arm indicates apex cover jett		
CDR		SECS LOGIC (both) - OFF	8	Lever lock.
		cb ELS/CM SM SEP (2) - open		
		SECS LOGIC (both) - on (up)		Lever lock.
		If MSFN GO		
		cb ELS/CM SM SEP BAT A - close		
		cb ELS/CM SM SEP BAT B - open (verify)		
		If MSFN GO		
		cb ELS/CM SM SEP BAT B - open (verify), close at or after apex cover jett at 24K'		
		Continue norm entry		
		If still indicates apex cover jett		
		cb ELS/CM SM SEP BAT B - close		
		cb ELS/CM SM SEP BAT A - open		
		SECS LOGIC (both) - OFF, then ON		
		MSFN confirm GO		
		cb ELS/CM SM SEP BAT A - open (verify), close at or after apex cover jett at 24K'		
		Continue norm entry		
		If still indicates apex cover jett		
		cb SECS LOGIC A - open		

STA/T	STEP	PROCEDURE	PANEL	REMARKS
		If MSFN GO		
CDR		cb SECS LOGIC A - open (verify), close at or after apex cover jett at 24K'	8	
		Continue norm entry		
		If still indicates apex cover jett		
		cb SECS LOGIC A - close		
		cb SECS LOGIC B - open		
		If MSFN GO		
		cb SECS LOGIC B - open (verify), close at or after apex cover jett at 24K'		
		Continue norm entry		
		If still indicates apex cover jett		
		ELS AUTO - MAN	1	
		ELS LOGIC - OFF		Guarded.
		SECS LOGIC (both) - OFF	8	Lever lock.
		cb SECS LOGIC (2) - open		
		cb SECS ARM (2) - open		
CMP		cb PYRO A&B/SEQ A&B (2) - open	250	
LMP		Pyro bus A&B - 0 vdc (verify)	3	
CMP		Use tool E (5/32 allen head) to remove closeout pnl located beneath pnl 276 (≈10 fasteners on pnl)		
		Remove or cut all wires to conn (P545) marked "cut" with white tag. Tape ends of wires cut. Replace closeout pnl		
		cb PYRO A&B/SEQ A&B (2) - close	250	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
LMP		Pyro bus A&B voltage - >35 vdc (verify)	3	
CDR		cb ELS/CM SM SEP (2) - close	8	
		cb SECS LOGIC (2) - close		
		cb SECS ARM (2) - open (verify)		
		<u>DO NOT ARM PYRO BUSES</u>		
		Continue norm entry except Perform CM RCS Pressurization, 4.15.1.4, & CM/SM Separation, 4.15.2, together at which time arm pyros as follows		
		PYRO B ARM - SAFE (verify)		Lever lock.
		PYRO A ARM - on (up)		Lever lock.
		To jett apex cover at 24K' PYRO B ARM - on (up)		Lever lock.
		Continue norm entry		
	5.3.2.9	<u>One Y Strut Will Not Fully Extend and Lock</u>		The other Y strut should be extended and locked as the following operations are performed.
	1	Break lockwire on one Y strut adjustment jam nut of the affected Y strut		
	2	Using tool F, unscrew jam nut		
	3	Disengage washer key so that strut bearing pad will turn		
	4	Screw strut bearing pad inbd until strut can be extended & locked		
	5	Replace washer key, & tighten jam nut		Lockwire and key not required for water landing.

STA/T	STEP	PROCEDURE	PANEL	REMARKS
	5.3.2.10	<u>CM RCS Fails to Pressurize or Feed Propellant</u>		
	1	Verify elect for pressurization		
CMP		cb EPS BAT BUS (2) - close	229	
		cb PYRO A/SEQ A - close	250	
		cb PYRO B/SEQ B - close		
CDR		cb SECS ARM (2) - close	8	
		SECS PYRO ARM (2) - on (up)		Lever lock.
		SECS LOGIC (both) - on (up)		Lever lock.
CMP	2	Cycle CM RCS PRESS - on (up)	2	
	3	Verify elect to CM RCS prplnt vlvs		
		cb EPS GRP 1 & 3 (4) - close	229	
CDR		cb SM RCS HTR A&B (2) - close	8	
		cb RCS PRPLNT (2) - close		
CMP	4	Cycle CM RCS PRPLNT (both) - on (up)	2	
	5	Open He & PRPLNT crossfeed		
		cb EPS GRP 5 (2) - close	229	
		cb RCS LOGIC (2) - close	8	
CDR		CM RCS LOGIC - on (up)	1	
		CM PRPLNT DUMP - on (up) (mom), then OFF		Guarded.
	5.3.3	POSTLANDING EMERGENCY PROCEDURES		
	5.3.3.1	<u>Fire/Smoke in CM During Postlanding</u>		
	a.	Stable I		
ALL		Don emer 02 mask (refer to Oper of Emer 02 Masks, 4.5.4.15)	2	

STA/T	STEP	PROCEDURE	PANEL	REMARKS
CDR		DIRECT O2 vlv - close (CW) (verify)	7	
CMP		cb ENTRY/PL BAT A, B, C (3) - open	250	
		cb PYRO A/SEQ A - open		
		cb PYRO B/SEQ B - open		
		Fire extinguisher - use as appropriate		Water dispenser used on all open nonelectrical fires. Foam fire extinguisher used on fires behind panels, closed compartments, and electrical fires.
	and/or	Egress CM (refer to Stable I Water Egress Procedure, 4.17.4.2)		
	b.	Stable II		
ALL		Don emer O2 mask (refer to Oper of Emer O2 Masks, 4.5.4.15)		
CDR		DIRECT O2 vlv - close (CW) (verify)	7	
CMP		Fire extinguisher - use as appropriate		Water dispenser used on all open nonelectrical fires. Foam fire extinguisher used on fires behind panels, closed compartments, and electrical fires.
		Upright CM to Stable I (refer to Postlanding Stab, Floating Inverted, 4.17.1) & proceed to step a		
		If CM fails to upright Perform Stable II Water Egress Procedure, 4.17.4.3		

APPENDIX B

CM PANEL ILLUSTRATIONS AND CONTROL/INDICATOR CONFIGURATION LIST FOR CSM 112

This section contains CM panel illustrations and a control/indicator configuration list for CSM 112. Panel illustrations present the location of the displays and controls as they appear on the panels in the CM The control/indicator configuration list provides the configuration of the CM displays and controls prior to backup crew cabin ingress, at lift-off, and during powered down configuration (low power consumption periods). Those talkbacks (tb) are included which reflect the last position selected of spring loaded switches. (Talkback indicators that are operated by sensors will not be listed.) The CSM control/indicator configuration list presents the panels in numerical sequence. The switches are not to be sequentially positioned as listed.

Constraints applicable to the spacecraft when in a powered down configuration are as follows:

- No contingency modes are assumed. Power up capability exists at all times for all systems.
- All spacecraft systems draw minimal power except communications, caution and warning, and life support subsystems. Power is removed from all backup communications systems. The G&C system has been powered down to the level defined by: Power Down Program (P06), 4.8.1.2, Optics Power Control, 4.8.1.4 step 2, and SCS Power Down, 4.8.4.1.
- Power shall be removed from redundant monitoring and unnecessary flight qualification instrumentation by opening applicable circuit breakers.

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 1			
EMS FUNC	OFF	ΔV	OFF
EMS MODE	STBY	STBY	STBY
GTA sw	off (down)	off (down)	N/A
EMS GTA COVER	Secure	Secure	N/A
CMC ATT	IMU	IMU	IMU
FDAI SCALE	5/1	5/5	5/1
FDAI SEL	1/2	1/2	1 or 2
FDAI SOURCE	CMC	CMC	CMC
ATT SET	GDC	GDC	IMU
MAN ATT ROLL	RATE CMD	RATE CMD	RATE CMD
MAN ATT PITCH	ACCEL CMD	ACCEL CMD	RATE CMD
MAN ATT YAW	RATE CMD	RATE CMD	RATE CMD
LIM CYCLE	OFF	OFF	on (up)
ATT DBD	MIN	MIN	MAX
RATE	HI	HI	LO

THC PWR	OFF	on (up)	as desired
RHC PWR NORM 1	OFF	AC/DC	OFF
RHC PWR NORM 2	OFF	AC/DC	OFF
RHC PWR DIR 1	OFF	MNA/MNB	OFF
RHC PWR DIR 2	OFF	MNA/MNB	OFF
SC CONT	SCS	SCS	as desired
CMC MODE	FREE	FREE	FREE
BMAG MODE ROLL	RATE 2	RATE 1	RATE 2
BMAG MODE PITCH	RATE 2	RATE 1	RATE 2
BMAG MODE YAW	RATE 2	RATE 1	RATE 2
SPS THRUST	NORM (locked)	NORM (locked)	NORM (locked)
ΔV THRUST A	OFF (guarded)	OFF (guarded)	OFF (guarded)
ΔV THRUST B	OFF (guarded)	OFF (guarded)	OFF (guarded)
SCS TVC PITCH	RATE CMD	AUTO	as desired
SCS TVC YAW	RATE CMD	AUTO	as desired
GMBL MOT P1	OFF	OFF	OFF
GMBL MOT P2	OFF	OFF	OFF
GMBL MOT Y1	OFF	OFF	OFF

PANEL 1

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 1 (CONT)			
GMBL MOT Y2	OFF	OFF	OFF
ΔV CG	LM/CSM	LM/CSM	CSM
ELS LOGIC	OFF (guarded)	OFF (guarded)	OFF (guarded)
ELS AUTO	AUTO	AUTO	N/A
CM RCS LOGIC	OFF	on (up)	OFF
CM PRPLNT DUMP	OFF (guarded)	OFF (guarded)	OFF (guarded)
CM PRPLNT PURG	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
IMU CAGE	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
EMS ROLL	OFF	OFF	OFF
.05 G sw	OFF	OFF	OFF
α/Pc IND sw	α	α	as desired
LV IND/GPI sw	SII/SIVB	SII/SIVB	GPI
TVC GMBL DR PITCH	AUTO	AUTO	1
TVC GMBL DR YAW	AUTO	AUTO	1

EVNT TMR RSET	up (ctr)	up (ctr)	up (ctr)
EVNT TMR START	ctr	ctr	STOP
EVNT TMR MIN	ctr	ctr	ctr
EVNT TMR SEC	ctr	ctr	ctr

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 2			
PL VENT VLV	push (lock)	push (lock)	push (lock)
PROBE EXTD/REL	OFF (guarded)	OFF (guarded)	OFF (guarded)
PROBE EXTD/REL A tb	gray	gray	gray
PROBE EXTD/REL B tb	gray	gray	gray
PROBE RETR PRIM	OFF	OFF	OFF
PROBE RETR SEC	OFF	OFF	OFF
EXT RUN/EVA LTS	OFF	OFF	OFF
EXT RNDZ LTS	off (ctr)	off (ctr)	off (ctr)
TUNL LTS	OFF	OFF	OFF
LM PWR	OFF	OFF	OFF
SM RCS A He 1	ctr (CLOSE*)	ctr (OPEN*)	N/A
SM RCS A He 1 tb	bp	gray	N/A
SM RCS B He 1	ctr (CLOSE*)	ctr (OPEN*)	N/A
SM RCS B He 1 tb	bp	gray	N/A
SM RCS C He 1	ctr (CLOSE*)	ctr (OPEN*)	N/A

SM RCS C He 1 tb	bp	gray	N/A
SM RCS D He 1	ctr (CLOSE*)	ctr (OPEN*)	N/A
SM RCS D He 1 tb	bp	gray	N/A
UP TLM CM	BLOCK	BLOCK	as desired
UP TLM IU	BLOCK	BLOCK	as desired
CM RCS PRESS	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
SM RCS IND sw	N/A	PRPLNT QTY	N/A
SM RCS A He 2	ctr (CLOSE*)	ctr (OPEN*)	N/A
SM RCS A He 2 tb	bp	gray	N/A
SM RCS B He 2	ctr (CLOSE*)	ctr (OPEN*)	N/A
SM RCS B He 2 tb	bp	gray	N/A
SM RCS C He 2	ctr (CLOSE*)	ctr (OPEN*)	N/A
SM RCS C He 2 tb	bp	gray	N/A
SM RCS D He 2	ctr (CLOSE*)	ctr (OPEN*)	N/A
SM RCS D He 2 tb	bp	gray	N/A
SM RCS A HTRS	OFF	OFF	N/A
SM RCS B HTRS	OFF	OFF	N/A

*Identifies last momentary position switched to.

PANEL 2

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 2 (CONT)			
SM RCS C HTRS	OFF	OFF	N/A
SM RCS D HTRS	OFF	OFF	N/A
SM RCS A PRPLNT	ctr (CLOSE*)	ctr (OPEN*)	as desired
SM RCS A PRIM PRPLNT tb	bp	gray	--
SM RCS A SEC PRPLNT tb	bp	gray	--
SM RCS B PRPLNT	ctr (CLOSE*)	ctr (OPEN*)	as desired
SM RCS B PRIM PRPLNT tb	bp	gray	--
SM RCS B SEC PRPLNT tb	bp	gray	--
SM RCS C PRPLNT	ctr (CLOSE*)	ctr (OPEN*)	as desired
SM RCS C PRIM PRPLNT tb	bp	gray	--
SM RCS C SEC PRPLNT tb	bp	gray	--
SM RCS D PRPLNT	ctr (CLOSE*)	ctr (OPEN*)	as desired
SM RCS D PRIM PRPLNT tb	bp	gray	--
SM RCS D SEC PRPLNT tb	bp	gray	--
RCS CMD	ctr (OFF*)	ctr (OFF*)	ctr (OFF*)

RCS TRNFR	ctr (SM*)	ctr (SM*)	N/A
CM RCS 1 PRPLNT	ctr (OFF*)	ctr (on, up*)	as desired
CM RCS 1 PRPLNT tb	bp	gray	--
CM RCS 2 PRPLNT	ctr (OFF*)	ctr (on, up*)	as desired
CM RCS 2 PRPLNT tb	bp	gray	--
RCS A SEC FUEL PRESS	ctr (OPEN*)	ctr (CLOSE*)	N/A
RCS B SEC FUEL PRESS	ctr (OPEN*)	ctr (CLOSE*)	N/A
RCS C SEC FUEL PRESS	ctr (OPEN*)	ctr (CLOSE*)	N/A
RCS D SEC FUEL PRESS	ctr (OPEN*)	ctr (CLOSE*)	N/A
EDS AUTO	OFF	on (up)	OFF
CSM/LM FNL SEP 1	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
CSM/LM FNL SEP 2	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
CM/SM SEP 1	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
CM/SM SEP 2	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
SIVB/LM SEP	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
PRPLNT DUMP	AUTO	AUTO	N/A
2 ENG OUT sw	AUTO	AUTO	OFF

*Identifies last momentary position switched to.

PANEL 2

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 2 (CONT)			
LV RATES sw	AUTO	AUTO	OFF
TWR JETT 1	AUTO (guarded)	AUTO (guarded)	OFF
TWR JETT 2	AUTO (guarded)	AUTO (guarded)	OFF
LV GUID sw	IU	IU	IU
LV STAGE	OFF (guarded)	OFF (guarded)	OFF (guarded)
XLUNAR INJECT	INJECT	INJECT	N/A
MN REL	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
MSN TMR HRS	ctr	ctr	ctr
MSN TMR MIN	ctr	ctr	ctr
MSN TMR SEC	ctr	ctr	ctr
C/W NORM	NORM	BOOST	NORM
C/W CSM	CSM	CSM	CSM
C/W PWR	1	1	1
C/W LAMP TEST	ctr	ctr	ctr
MSN TMR	STOP	START	START

RCS IND sel	CM 2	SM D	as desired
CAB FAN 1	OFF	OFF	OFF
CAB FAN 2	OFF	OFF	OFF
H2 HTRS 1	OFF	OFF	AUTO
H2 HTRS 2	OFF	OFF	AUTO
02 HTRS 1	OFF	OFF	AUTO
02 HTRS 2	OFF	OFF	AUTO
02 PRESS IND sw	TK 1	SURGE TK	N/A
H2 FANS 1	OFF	OFF	as req
H2 FANS 2	OFF	OFF	as req
02 FANS 1	OFF	OFF	as req
02 FANS 2	OFF	OFF	as req
ECS IND sel	PRIM	PRIM	N/A
RAD FLOW CONT AUTO	AUTO	AUTO	AUTO
ECS RAD tb	gray	gray	gray
RAD FLOW CONT PWR	off (ctr)	off (ctr)	PWR
RAD MAN SEL	RAD 1	RAD 1	RAD 1
RAD PRIM HTR	off (ctr)	off (ctr)	1

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 2 (CONT)			
RAD SEC HTR	OFF	OFF	OFF
POT H2O HTR	OFF	OFF	OFF
SUIT H2O ACCUM AUTO	ctr	1	1
SUIT H2O ACCUM ON	ctr	ctr	N/A
SUIT HT EXCH	off (ctr)	off (ctr)	off (ctr)
SEC COOL EVAP	off (ctr)	off (ctr)	off (ctr)
SEC COOL PUMP	off (ctr)	off (ctr)	off (ctr)
H2O QTY IND sw	POT	POT	N/A
GLY EVAP IN TEMP	MAN	MAN	AUTO
GLY EVAP STM AUTO	MAN	MAN	AUTO
GLY EVAP STM INCR	ctr	ctr	N/A
GLY EVAP H2O FLOW	off (ctr)	off (ctr)	AUTO
CAB TEMP	MAN	MAN	AUTO
CAB TEMP tw	N/A	N/A	N/A
HI GAIN ANT TRACK	AUTO	AUTO	as desired

HI GAIN ANT BEAM	WIDE	WIDE	as desired
HI GAIN ANT PITCH cont	0°	0°	as desired
HI GAIN ANT YAW cont	180°	180°	as desired
HI GAIN ANT PWR	OFF	OFF	as desired
HI GAIN ANT SERVO	PRIM	PRIM	PRIM

PANEL 2

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 3			
VHF ANT	SM LEFT	SM LEFT	as desired
SPS INJ VLV A1 ind	CLOSE	CLOSE	CLOSE
SPS INJ VLV A2 ind	CLOSE	CLOSE	CLOSE
SPS INJ VLV B3 ind	CLOSE	CLOSE	CLOSE
SPS INJ VLV B4 ind	CLOSE	CLOSE	CLOSE
FC 1 RAD	off (ctr) (NORM*)	off (ctr) (NORM*)	off (ctr) (NORM*)
FC 1 RAD tb	gray	N/A	gray
FC 2 RAD	off (ctr) (NORM*)	off (ctr) (NORM*)	off (ctr) (NORM*)
FC 2 RAD tb	gray	N/A	gray
FC 3 RAD	off (ctr) (NORM*)	off (ctr) (NORM*)	off (ctr) (NORM*)
FC 3 RAD tb	gray	N/A	gray
FC 1 HTRS	on (up)	on (up)	on (up)
FC 2 HTRS	on (up)	on (up)	on (up)
FC 3 HTRS	on (up)	on (up)	on (up)
FC IND sel	2	2	as desired

SPS QTY TEST	ctr	ctr	ctr
OXID FLOW VLV INCR	INCR	INCR	INCR
OXID FLOW VLV PRIM	PRIM	PRIM	as desired
PUG MODE	NORM	NORM	as desired
FC 1 PURG	OFF	OFF	OFF
FC 2 PURG	OFF	OFF	OFF
FC 3 PURG	OFF	OFF	OFF
FC 1 REACS	ctr (on, up*)	ctr (on, up*)	N/A
FC 1 REACS tb	gray	gray	gray
FC 2 REACS	ctr (on, up*)	ctr (on, up*)	N/A
FC 2 REACS tb	gray	gray	gray
FC 3 REACS	ctr (on, up*)	ctr (on, up*)	N/A
FC 3 REACS tb	gray	gray	gray
FC 1 MNA	ctr (on, up*)	ctr (on, up*)	ctr (on, up*)
FC 1 MNA tb	gray	gray	gray
FC 2 MNA	ctr (on, up*)	ctr (on, up*)	ctr (on, up*)
FC 2 MNA tb	gray	gray	gray

*Identifies last momentary position switched to.

PANEL 3

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 3 (CONT)			
FC 3 MNA	OFF	OFF	OFF
FC 3 MNA tb	bp	bp	bp
MNA RSET	ctr (RSET*)	ctr (RSET*)	ctr (RSET*)
FC 1 MNB	OFF	OFF	OFF
FC 1 MNB tb	bp	bp	bp
FC 2 MNB	OFF	OFF	OFF
FC 2 MNB tb	bp	bp	bp
FC 3 MNB	ctr (on, up*)	ctr (on, up*)	ctr (on, up*)
FC 3 MNB tb	gray	gray	gray
MNB RSET	ctr (RSET*)	ctr (RSET*)	ctr (RSET*)
DC IND sel	MN A	MN A	as desired
BAT CHG	OFF	OFF	OFF
SPS He VLV 1	AUTO	AUTO	AUTO
SPS He VLV 1 tb	bp	bp	bp
SPS He VLV 2	AUTO	AUTO	AUTO

SPS He VLV 2 tb	bp	bp	bp
SPS LINE HTRS	off (ctr)	off (ctr)	as desired
SPS PRESS IND sw	He	He	as desired
S BD XPNDR	OFF	PRIM	as req
S BD PWR AMPL PRIM	PRIM	PRIM	as req
S BD PWR AMPL HI	off (ctr)	HI	HI
PWR AMPL tb	bp	gray	gray
S BD MODE VOICE	VOICE	VOICE	VOICE
S BD MODE PCM	PCM	PCM	PCM
S BD MODE RNG	RNG	RNG	as req
S BD AUX TAPE	ctr	ctr	ctr
S BD AUX TV	ctr	ctr	ctr
UP TLM DATA	DATA	DATA	DATA
UP TLM CMD	OFF	NORM	NORM
S BD ANT OMNI A	B	B	as req
S BD ANT OMNI	OMNI	OMNI	as req
VHF AM SQLCH A tw	noise +1	noise +1	noise +1

*Identifies last momentary position switched to.

PANEL 3

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 3 (CONT)			
VHF AM A	off (ctr)	off (ctr)	as req
VHF AM B	off (ctr)	DUPLEX	off (ctr)
VHF AM RCV	off (ctr)	off (ctr)	off (ctr)
VHF BCN	OFF	OFF	OFF
VHF RNG	OFF	OFF	OFF
S BD SQLCH	ENBL	ENBL	ENBL
FC REAC VLVS	NORM	LATCH	NORM
H2 PURG LINE HTR	OFF	OFF	OFF
VHF AM SQLCH B tw	noise +1	noise +1	noise +1
TAPE RCDR PCM	PCM/ANLG	PCM/ANLG	PCM/ANLG
TAPE RCDR RCD	RCD	RCD	RCD
TAPE RCDR FWD	off (ctr)	FWD	FWD
TAPE MOTION tb	bp	gray	gray
SCE PWR	NORM	NORM	NORM
PMP PWR	NORM	NORM	NORM
PCM BIT RATE	HI	HI	LO

INV 1	MNA	MNA	MNA
INV 2	MNB	MNB	MNB
INV 3	OFF	OFF	OFF
INV 1 AC1	on (up)	on (up)	on (up)
INV 2 AC1	OFF	OFF	OFF
INV 3 AC1	OFF	OFF	OFF
AC1 RSET	ctr (RSET*)	ctr (RSET*)	ctr (RSET*)
INV 1 AC2	OFF	OFF	OFF
INV 2 AC2	on (up)	on (up)	on (up)
INV 3 AC2	OFF	OFF	OFF
AC2 RSET	ctr (RSET*)	ctr (RSET*)	ctr (RSET*)
AC IND sel	BUS 2 ØC	BUS 2 ØC	as desired

*Identifies last momentary position switched to.

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 4			
SPS GAUGING	AC1	AC1	as desired
TELCOM GRP 1	AC1	AC1	AC1
TELCOM GRP 2	AC2	AC2	AC2
GLY PUMPS	OFF	1 AC1	1 AC1
SUIT COMPR 1	OFF	AC1	AC1
SUIT COMPR 2	OFF	OFF	OFF
cb SUIT COMPR AC1 ØA	close	close	close
cb SUIT COMPR AC1 ØB	close	close	close
cb SUIT COMPR AC1 ØC	close	close	close
cb SUIT COMPR AC2 ØA	close	close	close
cb SUIT COMPR AC2 ØB	close	close	close
cb SUIT COMPR AC2 ØC	close	close	close
cb GLY PUMPS AC1 ØA	close	close	close
cb GLY PUMPS AC1 ØB	close	close	close
cb GLY PUMPS AC1 ØC	close	close	close

cb GLY PUMPS AC2 ØA	close	close	close
cb GLY PUMPS AC2 ØB	close	close	close
cb GLY PUMPS AC2 ØC	close	close	close

PANEL 4

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 5			
FC 1 PUMPS	AC1	AC1	AC1
FC 2 PUMPS	AC2	AC2	AC2
FC 3 PUMPS	AC2	AC2	AC2
G/N PWR	AC1	AC1	OFF
MN BUS TIE BAT A/C	OFF	on (up)	OFF
MN BUS TIE BAT B/C	OFF	on (up)	OFF
BAT CHGR	AC1	AC1	as desired
NONESS BUS	MNA	MNA	OFF
cb SNSR SIG MNA	close	close	close
cb SNSR SIG MNB	close	close	close
cb SNSR SIG AC1	close	close	close
cb SNSR SIG AC2	close	close	close
cb C/W MNA	close	close	close
cb C/W MNB	close	close	close
cb LM PWR 1 MNB	close	close	close

cb INV CONT 1	close	close	close
cb INV CONT 2	close	close	close
cb INV CONT 3	close	close	close
cb DC SNSR UNIT A	close	close	close
cb DC SNSR UNIT B	close	close	close
cb AC SNSR UNIT 1	close	close	close
cb AC SNSR UNIT 2	close	close	close
cb BAT RLY BUS BAT A	close	close	close
cb BAT RLY BUS BAT B	close	close	close
cb LM PWR 2 MNB	close	close	close
INTGL LTS	on	as desired	as desired
FLOOD LTS	OFF (full dim or full BRT)	OFF (full dim or full BRT)	OFF (full dim or full BRT)
FLOOD DIM	1	1	1
FLOOD FIXED	OFF	OFF	OFF
cb RAD CONTR AC1	close	close	close
cb RAD CONTR AC2	close	close	close
cb RAD CONT/HTRS MNA	close	close	close
cb RAD CONT/HTRS MNB	close	close	close

PANEL 5

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 5 (CONT)			
cb RAD HTRS OVLD BAT A	close	close	close
cb RAD HTRS OVLD BAT B	close	close	close
cb BAT CHGR BAT A	close	close	close
cb BAT CHGR BAT B	close	close	close
cb BAT CHGR MNA	close	close	close
cb BAT CHGR MNB	close	close	close
cb BAT CHGR AC PWR	close	close	close
cb ESS INST MNA	close	close	close
cb ESS INST MNB	close	close	close
cb NONESS INST	open	open	open
cb SCI EQUIP SEB 1	close	close	open
cb SCI EQUIP SEB 2	close	close	open
cb SCI EQUIP HATCH	open	open	open
cb POT H2O HTR MNA	close	close	close
cb POT H2O HTR MNB	close	close	close

cb H2O ACCUM MNA	close	close	close
cb H2O ACCUM MNB	close	close	close
cb WASTE/POT H2O XDUCR MNA	close	close	close
cb WASTE/POT H2O XDUCR MNB	close	close	close
cb ECS PRESS XDUCR 1 MNA	close	close	close
cb ECS PRESS XDUCR 1 MNB	close	close	close
cb ECS PRESS XDUCR 2 MNA	close	close	close
cb ECS PRESS XDUCR 2 MNB	close	close	close
cb ECS TEMP XDUCR MNA	close	close	close
cb ECS TEMP XDUCR MNB	close	close	close
cb SEC COOL AC1	close	close	close
cb SEC COOL AC2	close	close	close
cb SEC COOL RAD HTR MNA	close	close	close
cb SEC COOL XDUCR MNA	close	close	close
cb SEC COOL XDUCR MNB	close	close	close
cb WASTE DUMP HTRS MNA	open	open	close
cb WASTE DUMP HTRS MNB	open	open	close
cb CAB FAN 1 AC1 ØA	close	close	close

PANEL 5

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 5 (CONT)			
cb CAB FAN 1 AC1 ØB	close	close	close
cb CAB FAN 1 AC1 ØC	close	close	close
cb CAB FAN 2 AC2 ØA	close	close	close
cb CAB FAN 2 AC2 ØB	close	close	close
cb CAB FAN 2 AC2 ØC	close	close	close
cb G/N PWR AC1	close	close	close
cb G/N PWR AC2	close	close	close
cb G/N IMU MNA	close	close	close
cb G/N IMU MNB	close	close	close
cb G/N IMU HTR MNA	close	close	close
cb G/N IMU HTR MNB	close	close	close
cb G/N CMPTR MNA	close	close	close
cb G/N CMPTR MNB	close	close	close
cb G/N OPT MNA	close	close	close
cb G/N OPT MNB	close	close	close

PANEL 6

MODE	INTERCOM/PTT	as desired	as desired
VOX SENS tw	5	as req	as req
PWR	OFF	AUDIO/TONE	AUDIO/TONE
MASTER VOL tw	5	as req	as req
INTERCOM	T/R	T/R	T/R
INTERCOM VOL tw	5	as req	as req
PAD COMM	T/R	OFF	OFF
PAD COMM VOL tw	5	as desired	as desired
S BD	T/R	T/R	T/R
S BD VOL tw	5	as req	as req
VHF AM	T/R	T/R	T/R
VHF AM VOL tw	5	as req	as req
AUDIO CONT	NORM	NORM	NORM
SUIT PWR	OFF	on (up)	on (up)

PANELS 5 AND 6

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 7			
EDS PWR	OFF	on (up)	OFF
TVC SERVO PWR 1	OFF	AC1/MNA	OFF
TVC SERVO PWR 2	OFF	AC2/MNB	OFF
FDAI/GPI PWR	OFF	BOTH	OFF
LOGIC 2/3 PWR	on (up)	on (up)	OFF
ELEC PWR	OFF	GDC/ECA	OFF
SIG CONDR/DR BIAS PWR 1	OFF	AC1	OFF
SIG CONDR/DR BIAS PWR 2	OFF	AC2	OFF
BMAG 1 PWR	WARM UP	ON	WARM UP
BMAG 2 PWR	WARM UP	ON	WARM UP
DIRECT O2 vlv	OPEN (CCW)	partially OPEN (CCW)	N/A

PANEL 8			
cb SCS TVC AC1	close	close	close
cb SCS AC1	close	close	close
cb SCS AC2	close	close	close
AUTO RCS A/C ROLL A1	OFF	OFF	OFF
AUTO RCS A/C ROLL C1	OFF	OFF	OFF
AUTO RCS A/C ROLL A2	OFF	OFF	OFF
AUTO RCS A/C ROLL C2	OFF	OFF	OFF
AUTO RCS B/D ROLL B1	OFF	MNA	OFF
AUTO RCS B/D ROLL D1	OFF	MNB	OFF
AUTO RCS B/D ROLL B2	OFF	MNA	OFF
AUTO RCS B/D ROLL D2	OFF	MNB	OFF
AUTO RCS PITCH A3	OFF	MNB	OFF
AUTO RCS PITCH C3	OFF	MNA	OFF
AUTO RCS PITCH A4	OFF	MNA	OFF
AUTO RCS PITCH C4	OFF	MNB	OFF
AUTO RCS YAW B3	OFF	MNA	OFF
AUTO RCS YAW D3	OFF	MNB	OFF

PANELS 7 AND 8

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 8 (CONT)			
AUTO RCS YAW B4	OFF	MNB	OFF
AUTO RCS YAW D4	OFF	MNA	OFF
cb SCS ECA/TVC AC2	close	close	close
cb SCS DIR ULL MNA	close	close	close
cb SCS DIR ULL MNB	close	close	close
cb SCS CONTR 1 DIR MNA	close	close	close
cb SCS CONTR 1 DIR MNB	close	close	close
cb SCS CONTR 2 DIR MNA	close	close	close
cb SCS CONTR 2 DIR MNB	close	close	close
cb A/C ROLL MNA	close	close	as desired
cb A/C ROLL MNB	close	close	as desired
cb B/D ROLL MNA	close	close	as desired
cb B/D ROLL MNB	close	close	as desired
cb SCS PITCH MNA	close	close	as desired
cb SCS PITCH MNB	close	close	as desired

cb SCS YAW MNA	close	close	as desired
cb SCS YAW MNB	close	close	as desired
NUMERICS LTS	as desired	as desired	as desired
FLOOD LTS	OFF (full dim or full BRT)	OFF (full dim or full BRT)	OFF (full dim or full BRT)
INTGL LTS	as desired	as desired	as desired
cb ORDEAL AC2	close	close	close
cb ORDEAL MNB	close	close	close
cb SCS CONTR AUTO MNA	close	close	close
cb SCS CONTR AUTO MNB	close	close	close
cb SCS LOGIC 1/2 MNA	close	close	close
cb SCS LOGIC 3/4 MNA	close	close	close
cb SCS LOGIC 1/4 MNB	close	close	close
cb SCS LOGIC 2/3 MNB	close	close	close
cb SCS SYS MNA	close	close	close
cb SCS SYS MNB	close	close	close
FLOOD DIM	1	1	1
FLOOD FIXED	OFF	OFF	OFF
FLOAT BAG 1 L	VENT (locked)	VENT (locked)	OFF

PANEL 8

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 8 (CONT)			
FLOAT BAG 2 R	VENT (locked)	VENT (locked)	OFF
FLOAT BAG 3 CTR	VENT (locked)	VENT (locked)	OFF
SECS LOGIC 1	OFF (locked)	on (up) (locked)	OFF (locked)
SECS LOGIC 2	OFF (locked)	on (up) (locked)	OFF (locked)
SECS PYRO A ARM	SAFE (locked)	on (up) (locked)	SAFE (locked)
SECS PYRO B ARM	SAFE (locked)	on (up) (locked)	SAFE (locked)
cb CM RCS 1 HTR MNA	open	open	open
cb CM RCS 2 HTR MNB	open	open	open
cb SM RCS A HTR MNB	close	close	close
cb SM RCS C HTR MNB	close	close	close
cb SM RCS B HTR MNA	close	close	close
cb SM RCS D HTR MNA	close	close	close
cb RCS PRPLNT ISOL MNA	close	close	close
cb RCS PRPLNT ISOL MNB	close	close	close
cb RCS LOGIC MNA	close	close	close

cb RCS LOGIC MNB	close	close	close
cb EMS MNA	close	close	close
cb EMS MNB	close	close	close
cb DOCK PROBE MNA	close	close	close
cb DOCK PROBE MNB	close	close	close
cb SPS GAUGING MNA	close	close	close
cb SPS GAUGING MNB	close	close	close
cb SPS GAUGING AC1	close	close	close
cb SPS GAUGING AC2	close	close	close
cb SPS He VLV MNA	close	close	close
cb SPS He VLV MNB	close	close	close
cb SPS PITCH 1 BAT A	open	close	open
cb SPS PITCH 2 BAT B	close	close	close
cb SPS YAW 1 BAT A	open	close	open
cb SPS YAW 2 BAT B	close	close	close
cb SPS PILOT VLV A MNA	close	close	close
cb SPS PILOT VLV B MNB	close	close	close
cb FLOAT BAG 1 BAT A	open	open	open

PANEL 8

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 8 (CONT)			
cb FLOAT BAG 2 BAT B	open	open	open
cb FLOAT BAG 3 FLT/PL	open	open	open
cb SECS LOGIC A BAT A	open	close	close
cb SECS LOGIC B BAT B	open	close	close
cb SECS ARM A BAT A	open	close	open
cb SECS ARM B BAT B	open	close	open
cb EDS 1 BAT A	close	close	open
cb EDS 2 BAT C	close	close	open
cb EDS 3 BAT B	close	close	open
cb ELS/CM SM SEP BAT A	close	close	open
cb ELS/CM SM SEP BAT B	close	close	open
cb PL VENT FLT/PL	close	close	open

PANEL 9			
MODE	INTERCOM/PTT	as desired	as desired
VOX SENS tw	5	as req	as req
PWR	OFF	AUDIO/TONE	AUDIO/TONE
MASTER VOL tw	5	as req	as req
INTERCOM	T/R	T/R	T/R
INTERCOM VOL tw	5	as req	as req
PAD COMM	T/R	OFF	OFF
PAD COMM VOL tw	5	as desired	as desired
S BD	T/R	T/R	T/R
S BD VOL tw	5	as req	as req
VHF AM	T/R	T/R	T/R
VHF AM VOL tw	5	as req	as req
AUDIO CONT	NORM	NORM	NORM
SUIT PWR	OFF	on (up)	on (up)
VHF RNG	NORM	NORM	NORM

PANELS 8 AND 9

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 10			
MODE	INTERCOM/PTT	as desired	as desired
VOX SENS tw	5	as req	as req
PWR	OFF	AUDIO/TONE	AUDIO/TONE
MASTER VOL tw	5	as req	as req
PAD COMM	T/R	OFF	OFF
PAD COMM VOL tw	5	as desired	as desired
INTERCOM	T/R	T/R	T/R
INTERCOM VOL tw	5	as req	as req
S BD	T/R	T/R	T/R
S BD VOL tw	5	as req	as req
VHF AM	T/R	T/R	T/R
VHF AM VOL tw	5	as req	as req
AUDIO CONT	NORM	NORM	NORM
SUIT PWR	OFF	on (up)	on (up)

PANEL 12			
TUNL VENT vlv	OFF	LM/CM ΔP	N/A
PANEL 13			
FDAI 1 sw	INRTL	INRTL	INRTL
FDAI 2 sw	INRTL	INRTL	INRTL
EARTH/LUNAR	PWR OFF	PWR OFF	PWR OFF
ALT SET cont	100 NM	100 NM	N/A
LTG	OFF	OFF	OFF
MODE	HOLD/FAST	HOLD/FAST	N/A
SLEW	off (ctr)	off (ctr)	off (ctr)
PANEL 15			
COAS PWR	OFF	OFF	OFF
UTIL PWR	OFF	OFF	OFF
PL BCN LT	off (ctr)	off (ctr)	off (ctr)
PL DYE MARKER	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
PL VENT	OFF	OFF	OFF

PANELS 10 THRU 15

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 16			
DOCK TRGT	OFF	OFF	OFF
UTIL PWR	OFF	OFF	OFF
COAS PWR	OFF	OFF	OFF
PANEL 100			
UTIL PWR	OFF	OFF	OFF
FLOOD DIM	1	1	1
FLOOD FIXED	OFF	OFF	OFF
G/N OPT PWR	OFF	OFF	OFF
G/N IMU PWR	on (up) (guarded)	on (up) (guarded)	OFF (guarded)
RNDZ XPNDR PWR	OFF	OFF	OFF
NUMERICS LTS	as desired	as desired	OFF
FLOOD LTS	OFF (full dim or full BRT)	OFF (full dim or full BRT)	OFF (full dim or full BRT)
INTGL LTS	as desired	as desired	OFF

PANEL 101			
SYS TEST (LH)	4	4	OFF
SYS TEST (RH)	B	B	as desired
CM RCS HTRS	OFF	OFF	OFF
WASTE H2O DUMP	OFF	HTR A	HTR A
URINE DUMP	OFF	HTR A	HTR A
RNDZ XPNDR TEST	OPR	OPR	OPR
PANEL 122			
OPT ZERO	ZERO	ZERO	ZERO
OPT TELTRUN	SLAVE TO SXT	SLAVE TO SXT	SLAVE TO SXT
OPT COUPLING	DIRECT	DIRECT	DIRECT
OPT MODE	MAN	MAN	MAN
OPT SPEED	LO	LO	LO
COND LAMPS	ON	ON	as desired
UP TLM	ACPT	ACPT	as desired
PANEL 162			
SCI PWR (Located behind closeout panel and will be set at panel closeout)	OFF	OFF	OFF

PANELS 16 THRU 162

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 163			
SCI/UTIL PWR (Located behind closeout panel and will be set at panel closeout)	OFF	OFF	OFF
PANEL 164			
S1 (Located behind closeout panel and will be set at panel closeout)	OFF	OFF	OFF
PANEL 181			
CRYO AC PWR	on (up)	on (up)	OFF
H2 FAN	AUTO	AUTO	OFF
O2 FAN	AUTO	AUTO	OFF
cb SM SECTOR 1 AC2 ØA	close	close	open
cb SM SECTOR 1 AC2 ØB	close	close	open
cb SM SECTOR 1 AC2 ØC	close	close	open
SM/AC PWR	on (up)	on (up)	OFF
DOOR JETT	off (down) (guarded)	off (down) (guarded)	off (down) (guarded)
LOGIC PWR	OFF	OFF	OFF

cb LOGIC PWR MNA	close	close	open
cb LOGIC PWR MNB	close	close	open
PANEL 201			
AC UTIL PWR	OFF	OFF	OFF
PANEL 225			
cb PCM TLM ac GRP 1	close	close	close
cb PCM TLM ac GRP 2	close	close	close
cb FLT BUS MNA	close	close	close
cb FLT BUS MNB	close	close	close
cb PMP PRIM FLT BUS	close	close	close
cb PMP AUX FLT BUS	close	close	close
cb VHF/CREW AUDIO L FLT/PL	close	close	close
cb VHF/CREW AUDIO CTR FLT/PL	close	close	close
cb VHF/CREW AUDIO R FLT/PL	close	close	close
cb UDL FLT BUS	close	close	close
cb HI GAIN ANT FLT BUS	open	open	close
cb HI GAIN ANT ac GRP 2	open	open	close
cb S BD XMTR/DSE FLT BUS	close	close	close
cb S BD XMTR/DSE ac GRP 1	close	close	close

PANELS 163 THRU 225

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 225 (CONT)			
cb CTE MNA	close	close	close
cb CTE MNB	close	close	close
cb RNDZ XPNDR FLT BUS	close	close	close
cb SIG CONDR FLT BUS	close	close	close
cb S BD PWR AMPL 1 FLT BUS	close	close	close
cb S BD PWR AMPL 1 ac GRP 1	close	close	close
cb S BD PWR AMPL 2 FLT BUS	close	close	close
cb S BD PWR AMPL 2 ac GRP 2	close	close	close

PANEL 226			
cb FC 1 PUMPS AC	close	close	close
cb FC 1 REACS	open	open	open
cb FC 1 BUS CONT	close	close	close
cb FC 1 PURG	close	close	close
cb FC 1 RAD	close	open	open
cb CRYO H2 HTR 1 MNA	close	close	close
cb CRYO H2 HTR 2 MNB	close	close	close
cb FC 2 PUMPS AC	close	close	close
cb FC 2 REACS	open	open	open
cb FC 2 BUS CONT	close	close	close
cb FC 2 PURG	close	close	close
cb FC 2 RAD	close	open	open
cb CRYO O2 HTR 1 MNA	close	close	close
cb CRYO O2 HTR 2 MNB	close	close	close
cb FC 3 PUMPS AC	close	close	close
cb FC 3 REACS	open	open	open
cb FC 3 BUS CONT	close	close	close
cb FC 3 PURG	close	close	close

PANELS 225 AND 226

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 226 (CONT)			
cb FC 3 RAD	close	open	open
cb QTY AMPL AC1	close	close	close
cb QTY AMPL AC2	close	close	close
cb CRYO FAN TK1 AC1 ØA	close	close	close
cb CRYO FAN TK1 AC1 ØB	close	close	close
cb CRYO FAN TK1 AC1 ØC	close	close	close
cb CRYO FAN TK2 AC2 ØA	close	close	close
cb CRYO FAN TK2 AC2 ØB	close	close	close
cb CRYO FAN TK2 AC2 ØC	close	close	close
cb COAS/TUNL LTG MNA	close	close	close
cb COAS/TUNL LTG MNB	close	open	close
cb FLOOD LTG MNA	close	close	close
cb FLOOD LTG MNB	close	close	close
cb FLOOD LTG FLT/PL	close	close	close
cb NUM/INTGL LTG LEB AC2	close	close	close

cb NUM/INTGL LTG L MDC AC1	close	close	close
cb NUM/INTGL LTG R MDC AC1	close	close	close
cb RUN/EVA/TRGT LTG AC1	close	close	close
cb RUN/EVA/TRGT LTG AC2	close	close	close
PANEL 227			
SCI PWR	OFF	OFF	OFF
PANEL 229			
cb EPS GRP 1 MNA	close	close	close
cb EPS GRP 1 MNB	close	close	close
cb EPS GRP 2 MNA	close	close	close
cb EPS GRP 2 MNB	close	close	close
cb EPS GRP 3 MNA	close	close	close
cb EPS GRP 3 MNB	close	close	close
cb EPS GRP 4 MNA	close	close	close
cb EPS GRP 4 MNB	close	close	close
cb EPS GRP 5 MNA	close	close	close
cb EPS GRP 5 MNB	close	close	close
cb UTIL R/L STA MNA	close	close	close

PANELS 226 THRU 229

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 229 (CONT)			
cb UTIL LEB MNB	close	close	close
cb EPS BAT BUS A	close	close	close
cb EPS BAT BUS B	close	close	close
cb TMRS MNA	close	close	close
cb TMRS MNB	close	close	close
cb SPS LINE HTRS MNA	close	close	close
cb SPS LINE HTRS MNB	close	close	close
cb O2 VAC ION PUMPS MNA	open	open	open
cb O2 VAC ION PUMPS MNB	open	open	open
cb MN REL PYRO A	open	open	open
cb MN REL PYRO B	open	open	open

PANEL 230			
MAP CAMR ON tb	gray	gray	TBD
MAP CAMR TRACK tb	gray	gray	TBD
MAP CAMR ON	OFF	STBY	OFF
MAP CAMR TRACK	OFF	OFF	OFF
MAP CAMR IMAGE MTN	OFF	OFF	OFF
GAMMA RAY BOOM DPLY tb	gray	gray	TBD
GAMMA RAY BOOM JETT tb	gray	gray	TBD
GAMMA RAY BOOM DPLY	off (ctr)	off (ctr)	off (ctr)
GAMMA RAY BOOM JETT	off (down)	off (down)	off (down)
GAMMA RAY EXP	OFF	OFF	OFF
GAMMA RAY GAIN	SHLD OFF	SHLD OFF	SHLD OFF
MASS SPECT BOOM DPLY tb	gray	gray	TBD
MASS SPECT BOOM JETT tb	gray	gray	TBD
MASS SPECT BOOM JETT	off (down)	off (down)	off (down)
MASS SPECT BOOM DPLY	off (ctr)	off (ctr)	off (ctr)
MASS SPECT EXP	OFF	OFF	OFF
MASS SPECT ION SOURCE	OFF	OFF	OFF

PANELS 229 AND 230

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 230 (CONT)			
MASS SPECT MULT	LO	LO	LO
MASS SPECT DSCRM	LO	LO	LO
LASER ALTM	OFF	OFF	OFF
PAM CAMR OPR tb	gray	gray	TBD
PAN CAMR SELF TEST	off (ctr)	off (ctr)	off (ctr)
PAN CAMR MODE	STBY	STBY	STBY
PAN CAMP PWR	BOOST	BOOST	off (ctr)
DATA SYS CAL	off (down)	off (down)	off (down)
DATA SYS ON	OFF	OFF	OFF
ALPHA RAY	OFF	OFF	OFF
X RAY DR DPLY	off (down)	off (down)	off (down)
X RAY EXP	OFF	OFF	OFF
SUB SAT	off (ctr)	off (ctr)	off (ctr)
SUB SAT tb	gray	gray	gray

PANEL 250			
cb BAT BUS A TO PYRO BUS	open	open	open
cb PYRO A/SEQ A	close	close	close
cb BAT BUS B TO PYRO BUS	open	open	open
cb PYRO B SEQ B	close	close	close
cb BAT A PWR ENTRY/PL	close	close	close
cb BAT B PWR ENTRY/PL	close	close	close
cb BAT C PWR ENTRY/PL	close	close	close
cb BAT C TO BAT BUS A	open	open	open
cb BAT C TO BAT BUS B	open	open	open
cb BAT C BAT CHGR/EDS 2	close	close	close
PANEL 251			
OVBD DRAIN vlv	OFF	OFF	N/A
PANEL 252			
BAT VENT vlv	VENT	CLOSE	N/A
WASTE STOW vlv	CLOSE	VENT	N/A

PANELS 230 THRU 252

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 275			
cb MNA BAT BUS A	close	close	close
cb MNA BAT C	open	open	open
cb MNB BAT C	open	open	open
cb MNB BAT BUS B	close	close	close
cb FLT/PL BAT BUS A	open	open	open
cb FLT/PL BAT BUS B	open	open	open
cb FLT/PL BAT C	open	open	open
cb FLT/PL MNA	close	close	close
cb FLT/PL MNB	close	close	close
cb INV 1 MNA	close	close	close
cb INV 2 MNB	close	close	close
cb INV 3 MNA	close	close	close
cb INV 3 MNB	close	close	close

PANEL 276			
cb1 INST PWR CONT	close	close	close
cb2 INST PWR CONT	close	close	close
cb3 INST PWR CONT	close	close	close
cb4 INST PWR CONT	close	close	close
PANEL 278			
cb UPR SYS COMPR 1	open	open	open
cb UPR SYS COMPR 2	open	open	open
cb SIVB/LM SEP PYRO A	close	close	
cb SIVB/LM SEP PYRO B	close	close	
PANEL 300			
rh SUIT FLOW vlv	FULL FLOW	FULL FLOW	N/A
PANEL 301			
lh SUIT FLOW vlv	FULL FLOW	FULL FLOW	N/A
PANEL 302			
ctr SUIT FLOW vlv	FULL FLOW	FULL FLOW	N/A
PANEL 303			
PRIM CAB TEMP vlv	COLD (CW)	COLD (CW)	N/A
SEC CAB TEMP vlv	MAX COOL (CW)	MAX COOL (CW)	N/A

PANELS 275 THRU 303

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 304			
DRINK H2O SUP vlv	OFF (CW)	OFF (CW)	N/A
PANEL 305			
FOOD PREP COLD H2O vlv	rel	rel	N/A
FOOD PREP HOT H2O vlv	rel	rel	N/A
PANEL 306			
MSN TMR	START	START	START
EVNT TMR RSET	UP (ctr)	UP (ctr)	UP (ctr)
EVNT TMR START	ctr	ctr	STOP
EVNT TMR MIN	ctr	ctr	ctr
EVNT TMR SEC	ctr	ctr	ctr
MSN TMR HRS	ctr	ctr	ctr
MSN TMR MIN	ctr	ctr	ctr
MSN TMR SEC	ctr	ctr	ctr

PANEL 325			
rh CAB PRESS RELF vlv	BOOST/ENTR	BOOST/ENTR	N/A
lh CAB PRESS RELF vlv	BOOST/ENTR	BOOST/ENTR	N/A
PRIM GLY TO RAD	NORM	BYP	N/A
PANEL 326			
REPRESS PKG vlv	OFF	ON	N/A
SM O2 SUP vlv	ON	ON	N/A
SRG TK O2 vlv	ON	ON	N/A
GLY RSVR IN vlv	OPEN	OPEN	N/A
GLY RSVR BYP vlv	CLOSE	CLOSE	N/A
GLY RSVR OUT vlv	OPEN	OPEN	N/A
PANEL 350			
CO2 CSTR DIVERT vlv	ctr	ctr	N/A
PANEL 351			
MN REG A vlv	open	open	N/A
MN REG B vlv	open	open	N/A
H2O/GLY TK REG sel	BOTH	BOTH	N/A
H2O/GLY TK RELF sel	BOTH	BOTH	N/A

PANELS 304 THRU 351

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 351 (CONT)			
EMER CAB PRESS sel	OFF	OFF	N/A
CAB REPRESS vlv	OFF (CCW)	OFF (CCW)	N/A
PANEL 352			
WASTE TK SERV vlv	CLOSE	CLOSE	N/A
PRESS RELF sel	2	2	N/A
POT TK IN vlv	CLOSE	OPEN	N/A
WASTE TK IN vlv	AUTO	AUTO	N/A
PANEL 375			
SRG TK RELF vlv	open (CW)	open (CW)	N/A
PANEL 376			
PLVC sw	NORM	NORM	N/A
PANEL 377			
GLY TO RAD SEC vlv	BYP	BYP	N/A
PANEL 378			
PRIM GLY ACCUM vlv	open (CCW)	open (CCW)	N/A

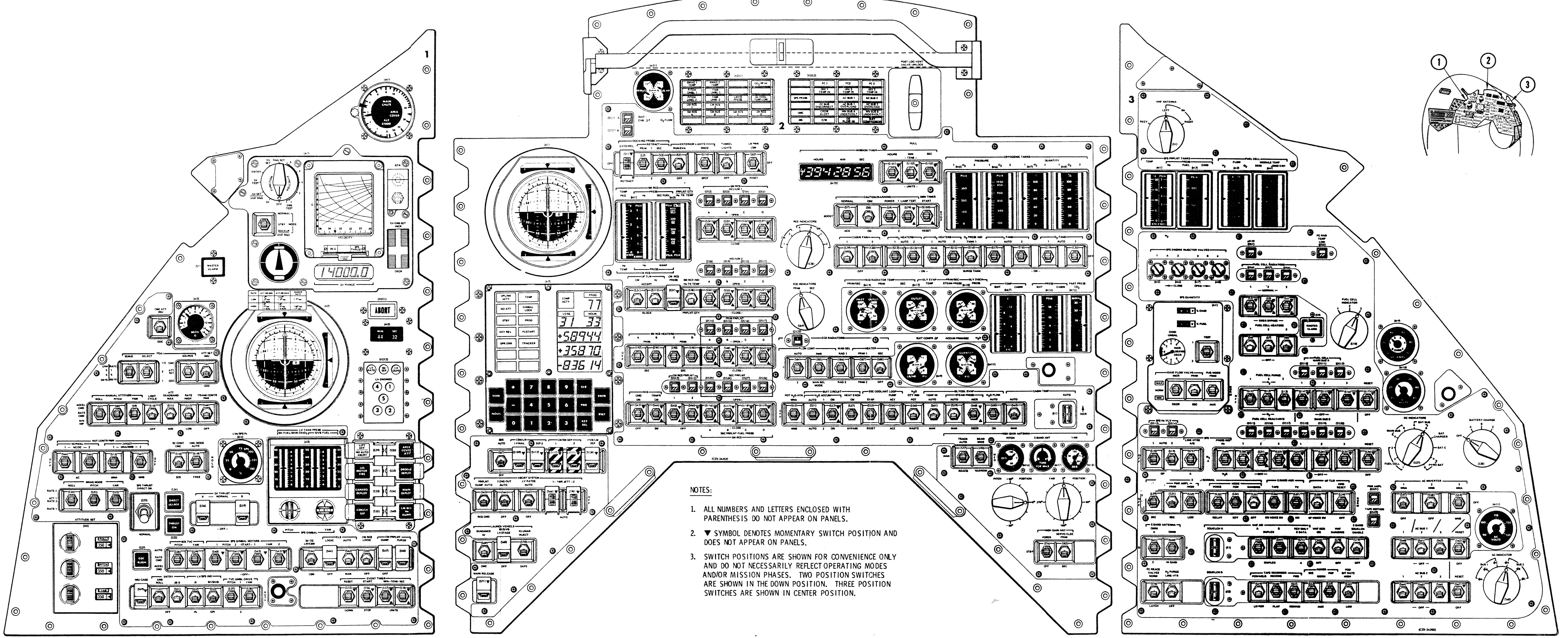
PANEL 379			
PRIM ACCUM FILL vlv	OFF	OFF	N/A
PANEL 380			
DEMAND REG sel	BOTH	BOTH	N/A
SUIT TEST vlv	OFF	OFF	N/A
SUIT RETURN vlv	close (push)	close (push)	N/A
PANEL 382			
SUIT HT EXCH PRIM GLY	FLOW (CCW)	FLOW (CCW)	FLOW
SUIT FLOW RELF	OFF	OFF	N/A
GLY EVAP IN TEMP vlv	MIN (CCW)	MIN (CCW)	N/A
SUIT HT EXCH SEC GLY	FLOW	FLOW	N/A
SEC EVAP H2O CONT	AUTO	AUTO	OFF
PRIM EVAP H2O CONT	AUTO	AUTO	AUTO
H2O ACCUM 1	RMTE	RMTE	RMTE
H2O ACCUM 2	RMTE	RMTE	RMTE
PANEL 600			
EMER O2	CLOSE	CLOSE	N/A
PANEL 601			
REPRESS O2	CLOSE	CLOSE	N/A

PANELS 351 THRU 601

NOMENCLATURE	CSM CONTROL/INDICATOR CONFIGURATION		
	PRIOR TO BACKUP CREW CABIN INGRESS	AT LIFTOFF	POWER DOWN
PANEL 602			
REPRESS O2 RELF	open (CW)	open (CW)	N/A
PANEL 603			
EVA STA O2 SUP	OFF	OFF	OFF
PANEL 604			
SUIT PRESS ALARM	OFF	OFF	OFF
FWD HATCH			
PRESS EQUAL vlv	CLOSE	CLOSE	N/A
Actr handle sel	stowed	stowed	N/A
Actr handle rel	locked	locked	N/A
SIDE HATCH			
CAB PRESS DUMP vlv	close (CW)	close (CW)	close (CW)
Gearbox sel	LATCH	LATCH	N/A
Actr handle sel	L (latch)	U (unlatch)	N/A
BPC jett knob	180° from BPC JETT decal	Arrow on knob pointing to BPC JETT decal	N/A

Lock pin rel knob	UNLOCK	LOCK	N/A
GN2 vlv handle	neutral	push (outboard)	N/A
Lock pin ind	flush	flush	N/A

PANELS 602 THRU 604, FWD HATCH AND SIDE HATCH



1. ALL NUMBERS AND LETTERS ENCLOSED WITH PARENTHESIS DO NOT APPEAR ON PANELS.
2. ▼ SYMBOL DENOTES MOMENTARY SWITCH POSITION AND DOES NOT APPEAR ON PANELS.
3. SWITCH POSITIONS ARE SHOWN FOR CONVENIENCE ONLY AND DO NOT NECESSARILY REFLECT OPERATING MODES AND/OR MISSION PHASES. TWO POSITION SWITCHES ARE SHOWN IN THE DOWN POSITION. THREE POSITION SWITCHES ARE SHOWN IN CENTER POSITION.

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Figure B-1. Crew Displays and Controls (Sheet 1 of 5)

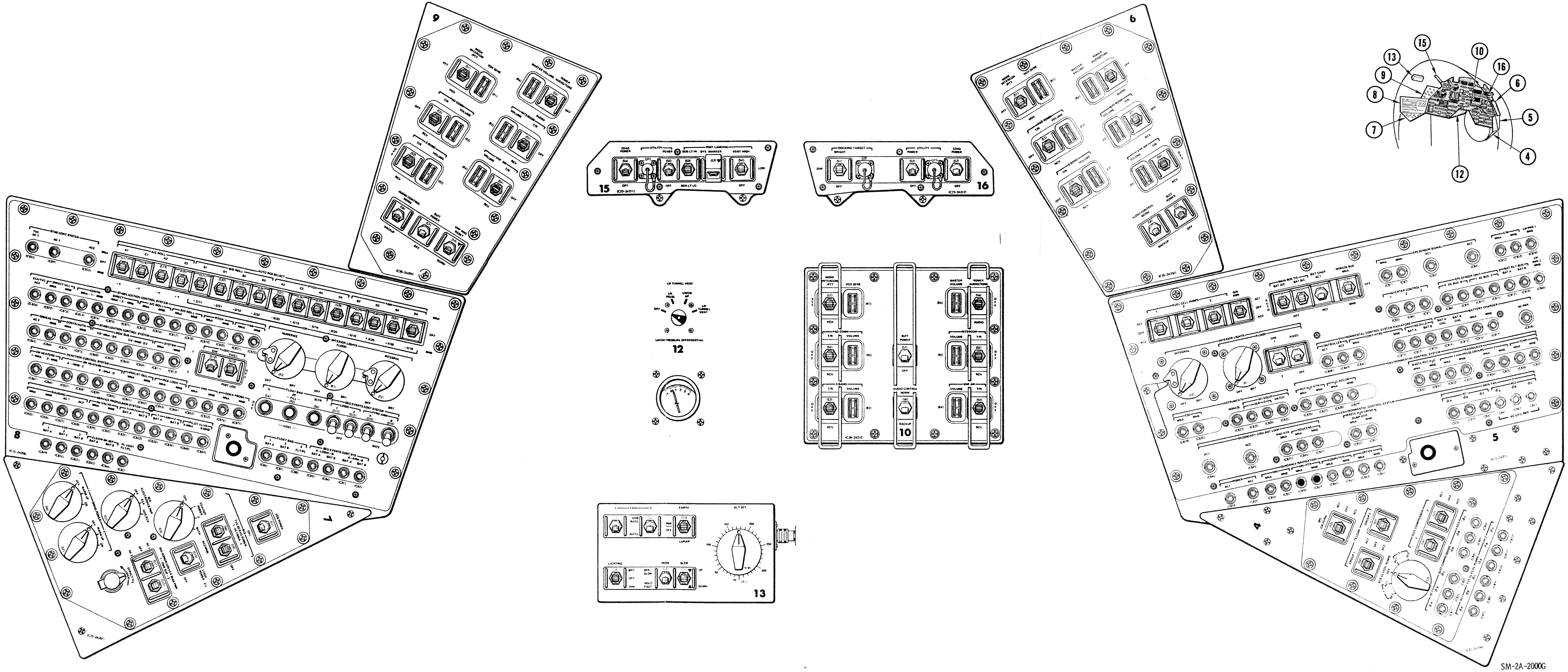

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Figure B-1. Crew Displays and Controls (Sheet 2 of 5)

*PANELS 162, AND 164 ARE LOCATED BEHIND VOLUME B5 AND B6 RESPECTIVELY. PANEL 163 IS LOCATED BEHIND CLOSEOUT PANEL ADJACENT TO VOLUME B2.

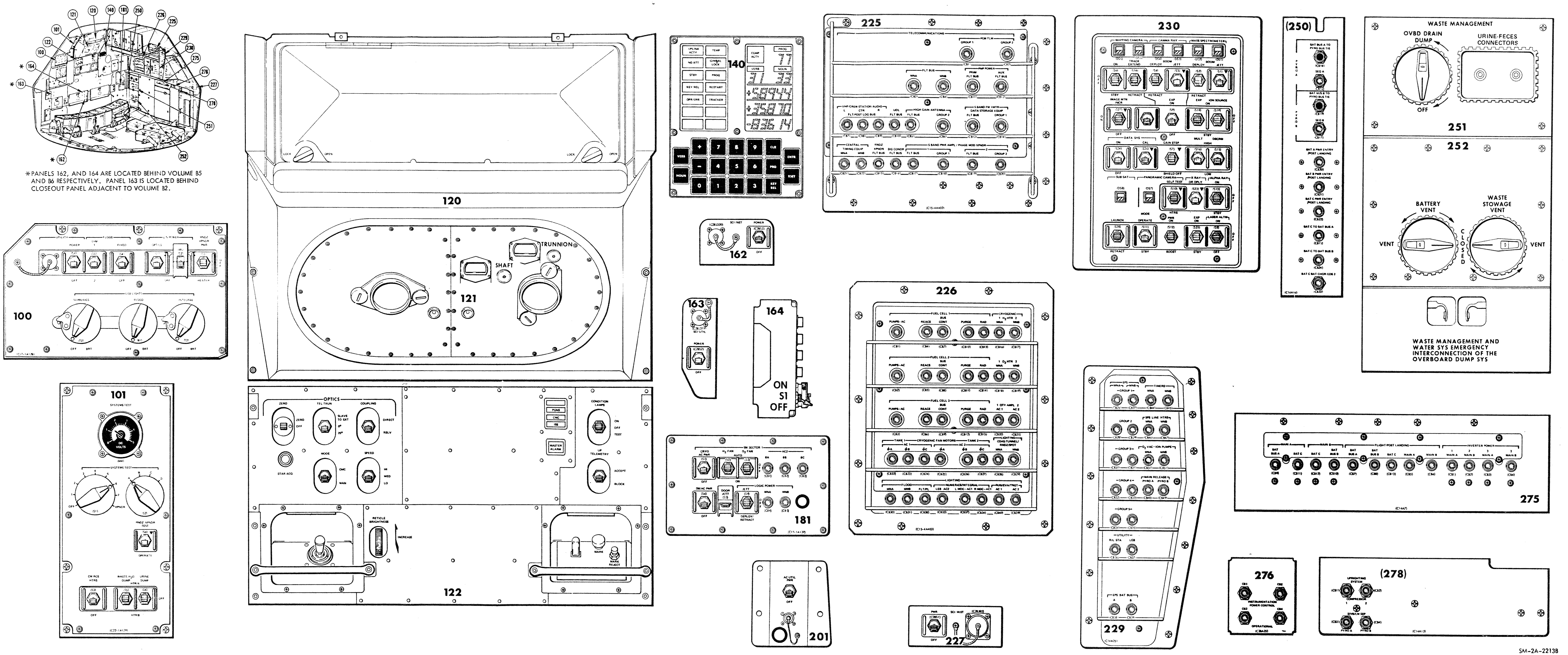

Figure B-1. Crew Displays and Controls (Sheet 3 of 5)

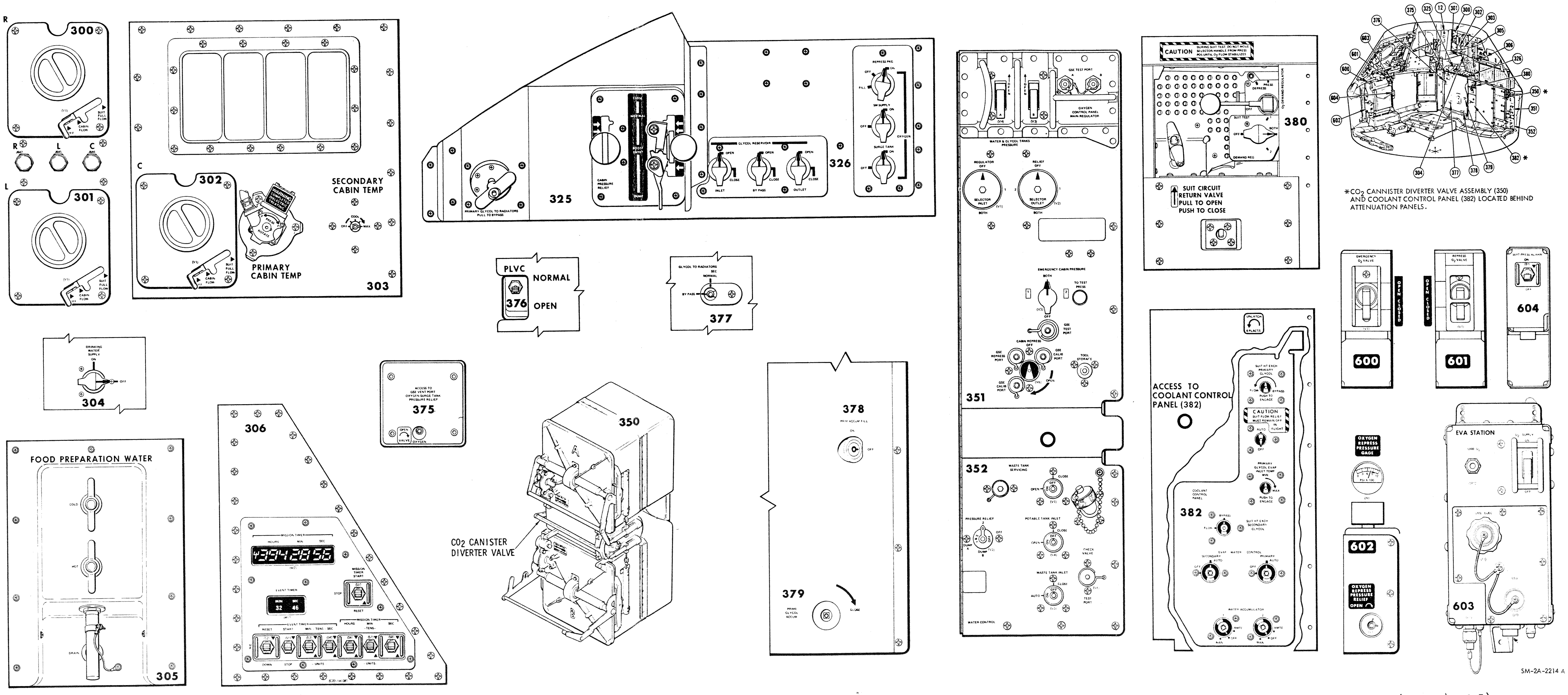

Figure B-1. Crew Displays and Controls (Sheet 4 of 5)

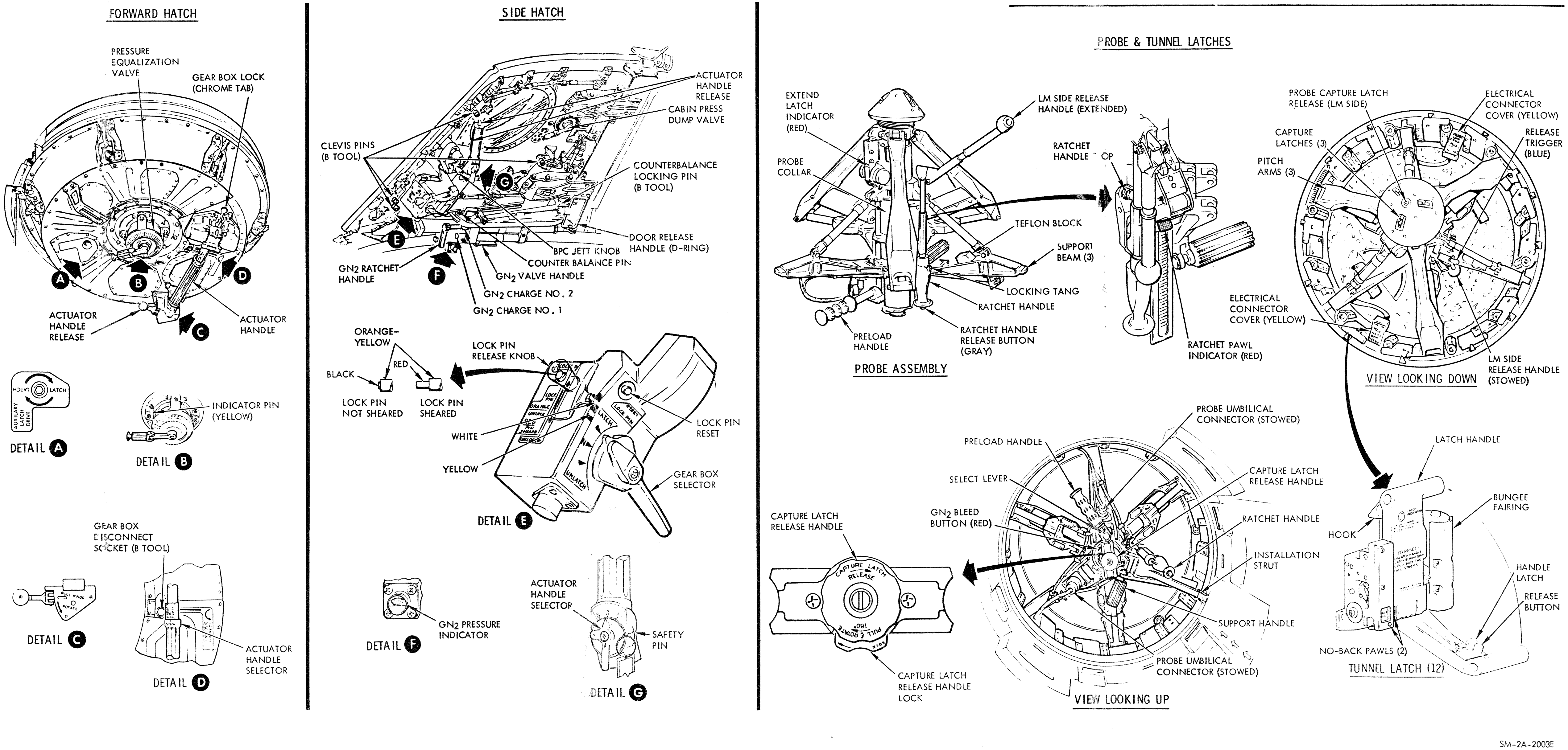

Figure B-1. Crew Displays and Controls (Sheet 5 of 5)

APPENDIX C

FLIGHT OPERATIONAL CHECKLIST DEVELOPMENT

The CSM Apollo Operations Handbook Procedures are formatted so as to make possible direct development of flight operational checklist material.

Figures C-1 through C-3 indicate a method of arranging material from the procedures column of the normal/backup and contingency sections of the AOH to provide three relatively compact and convenient checklists ordered and oriented to specific Apollo mission phases. Material is arranged to provide a minimum of redundancy and cross referencing, while at the same time allowing optimum procedure sequencing for each phase.

The LAUNCH CHECKLIST, figure C-1, contains flight crew procedures from prime crew ingress through translunar injection, including aborts and applicable pad and flight emergency procedures.

Backup crew prelaunch procedures can be made a carry-off item at the time of backup crew egress and are therefore not included. Prime crew prelaunch procedures could conceivably be excluded as well from the launch checklist by use of task communication to the crew via hardline.

The FLIGHT OPERATIONS CHECKLIST, figure C-2, includes CSM/LM/SIVB interface, rendezvous, formation flight, docking and docked operations, and flight emergency procedures for use during all phases of Earth-Lunar orbital operations. These procedures are also used for TEI and for MCC burns during translunar and transearth coast periods.

The ENTRY CHECKLIST, figure C-3, includes preparation for deorbit and entry through postlanding procedures including flight emergency procedures and postlanding emergency procedures, if any.

The SUPPORT PROCEDURES AND DATA (SPAD), detailed in figure C-4, includes G&C reference data, subprocedures, mode selection, and vehicle system management procedures used in conjunction with orbital operations and in preparation for deorbit and entry.

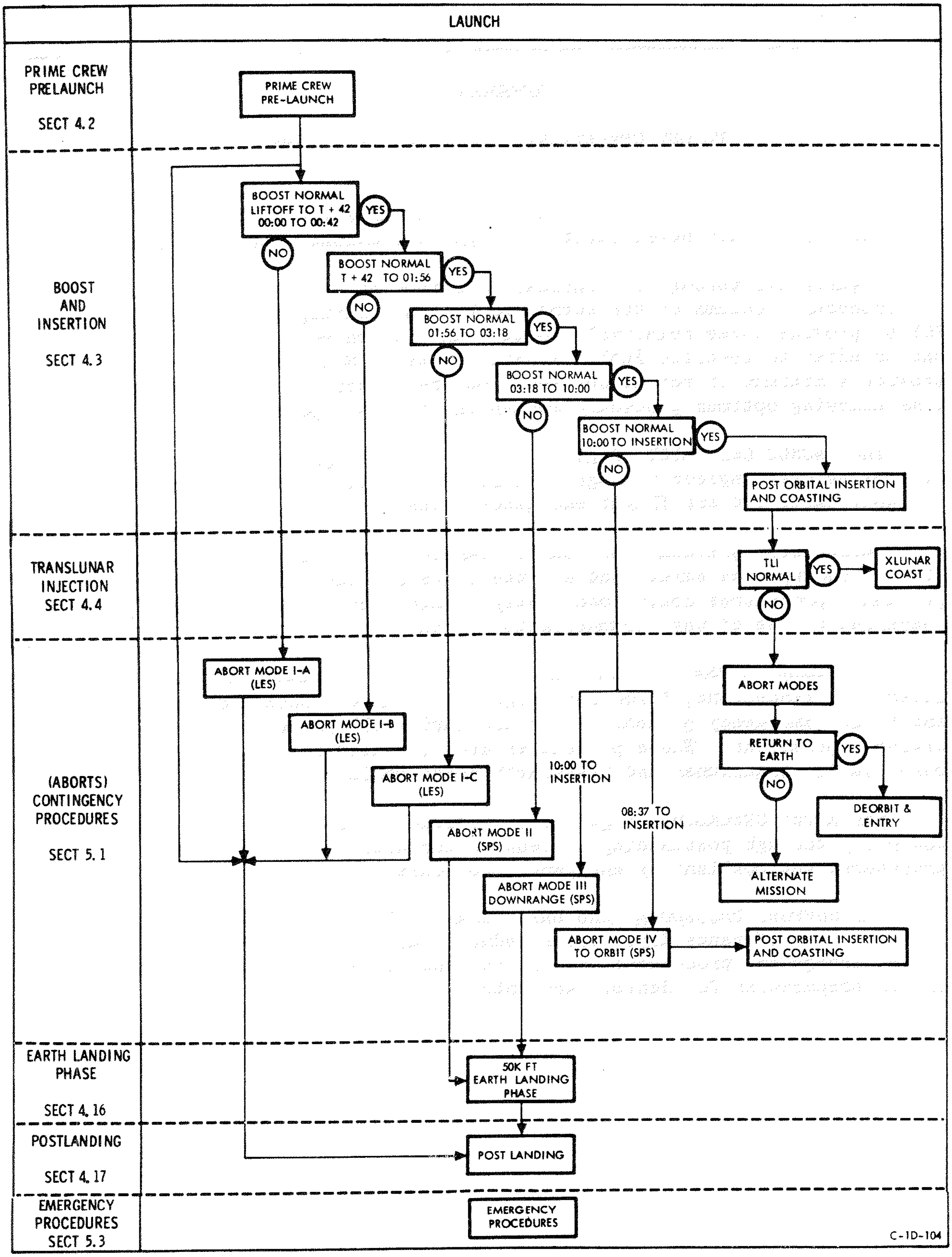

Figure C-1. Launch

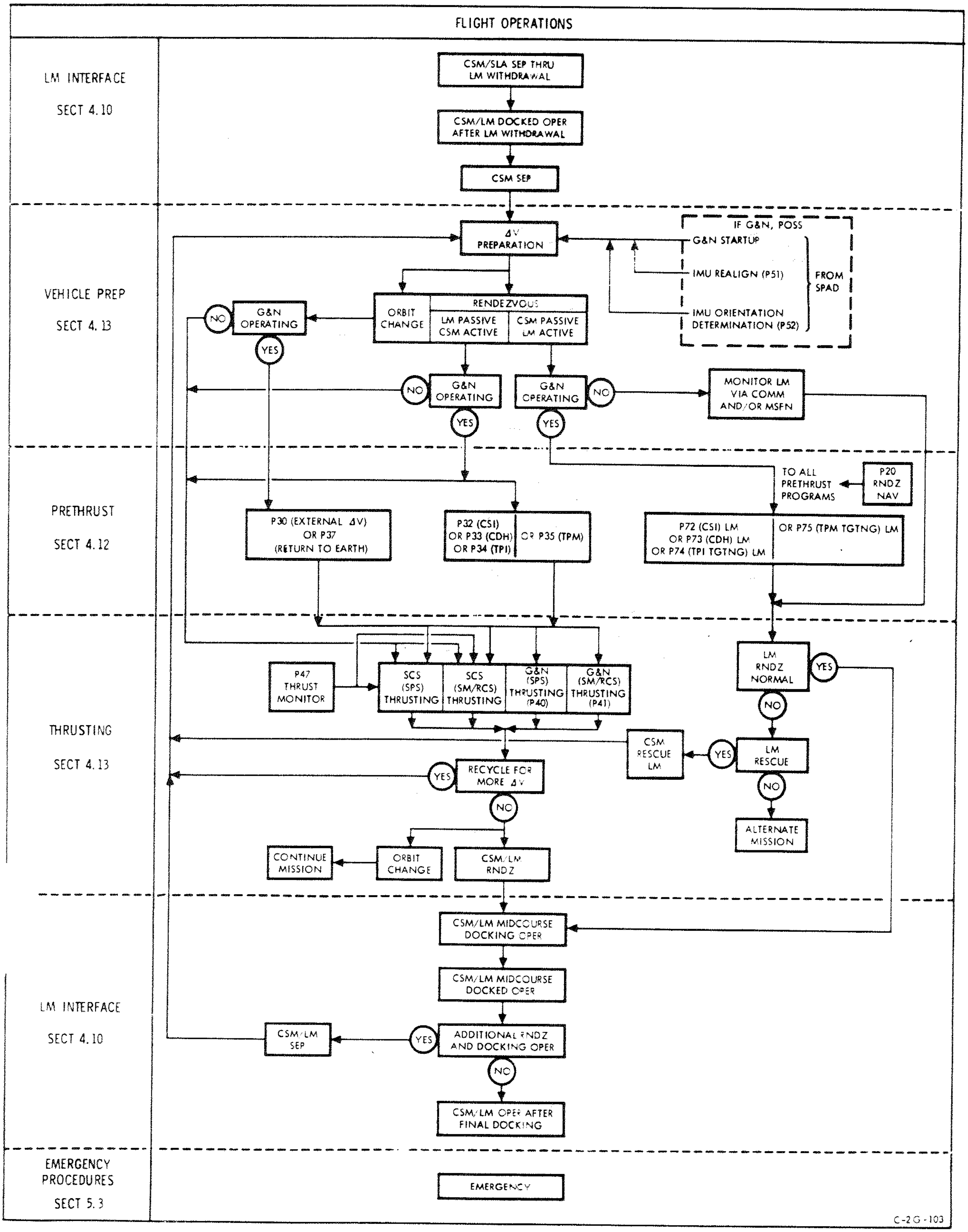

Figure C-2. Flight Operations

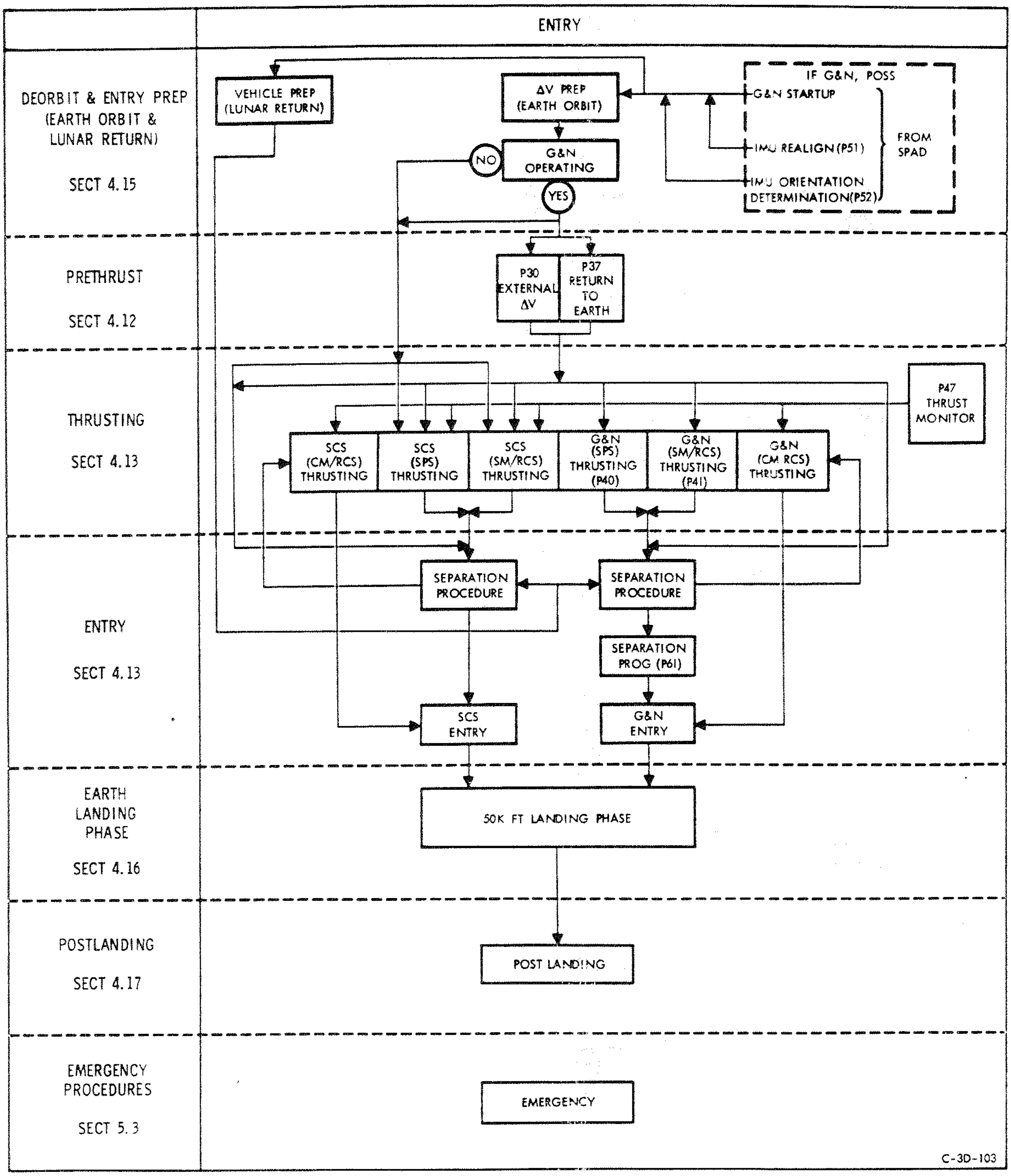

Figure C-3. Entry

SUPPORT PROCEDURES AND DATA

REFERENCE DATA SECT 4.6	G&C GENERAL INSTRUCTIONS G&C OPERATING NOTES G&C OPERATIONS SCS OPERATIONS G&N OPERATIONS OPTICS MECHANIZATION VERB LIST NOUN LIST STAR LIST CHECKLIST CODES OPTION CODES ALARM CODES CMC PROGRAM–ROUTINE CHECK • PROGRAMS • ROUTINES • CMC FLAG LISTINGS
G&C REFERENCE MODES SECT 4.7	ATTITUDE CONTROL MODES • CHANNEL SELECTION • SCS MINIMUM IMPULSE • SCS ACCELERATION COMMAND • SCS ATTITUDE HOLD/RATE COMMAND • CMC ACCEL CMD/MIN IMP • CMC ATT CONTR-AUTO/HOLD • SIVB ATT CONTR DISPLAY MODES • DYNAMIC DISPLAY MONITOR • RATE DISPLAY • ERROR DISPLAY (BMAG, CMC, ATT SET SOURCE) • TOTAL ATTITUDE DISPLAY • ORDEAL-LCL HORIZ ATT GDC ALIGN TVC MODES • SPS THRUSTING • TVC INITIALIZATION • SPS GMBL CONTR • THRUST ON-OFF CONTR OPTICS CONTROL • AUTO OPT POSITIONING • MAN OPT CONTR • MAN OPT DRIVE ENTRY MONITOR SYSTEM (EMS) • ΔV TEST AND NULL BIAS CHECK • ΔV SETUP
G&C GENERAL PROCEDURES SECT 4.8	G&N GENERAL • (P00) CMC IDLING PROGRAM • (P06) CMC/IMU POWER DOWN PROCEDURES • STARTUP PROCEDURE • OPTICS POWER CONTROL • (P27) CMC UPDATE • (P47) G&N THRUSTING MONITOR PROGRAM • CMC SELF-CHECK PROCEDURE • MEASUREMENT AND LOADING OF PIPA BIAS • (R33) CMC/LGC CLOCK SYNC ROUTINE • ΔR AND ΔV THRESHOLD CHANGE PROCEDURE • A OR B ERASABLE VALUE CHANGE PROCEDURE • FLAGWORD MONITOR AND CHANGE PROCEDURE • (V79) ORBRATE/PTC (BBQ MODE - R64) • G&N PASSIVE THERMAL CONTROL PROCEDURE • G&N +X LANDMARK TRACKING • SATURN RATE CHANGE • (R02) IMU STATUS CHECK • (R05) S BAND ANTENNA ROUTINE • DSKY 88888 CLEAR PROCEDURE DIGITAL AUTO PILOT (DAP) • (V48) DAP DATA LOAD ACTIVATION (R03) • RCS DAP ATTITUDE DEADBAND CHANGE PROCEDURE • RCS DAP ORBITAL RATE PROCEDURE EXTENDED VERBS • (V35) DSKY CONDITION LIGHT CHECK • (V42) TORQUE GYROS • (V43) LOAD FDAI ERROR NEEDLES • (V49) CSM CREW DEFINED MANEUVER (R62) • (V67) START W-MATRIX RSS ERROR DISPLAY • (V74) INITIALIZE ERASABLE DUMP VIA DOWNLINK • (V91) DISPLAY BANKSUM SCS GENERAL • SCS POWER DOWN • SCS POWER UP • DRIFT RATE ADJUST • MINIMUM POWER SCS ATTITUDE HOLD (THREE OR TWO AXES) • SCS ATTITUDE MANEUVER • GDC ALIGNMENT TO IMU GIMBAL ANGLES • ATTITUDE REFERENCE SYSTEM COMPARISON • ORDEAL INITIALIZATION • SCS PASSIVE THERMAL CONTROL USING WOBBLE MODE • SCS PASSIVE THERMAL CONTROL USING BAR-B-Q MINIMUM POWER MODE
NAVIGATION SECT 4.11	ORBITAL NAV • (P21) GROUND TRACK DETERMINATION • (P22) ORBITAL NAVIGATION • (P23) CISLUNAR MIDCOURSE NAV • (P24) RATE AIDED OPTICS • (R30) ORBIT PARAMETER DISPLAY RENDEZVOUS NAV • (P20) CSM RENDEZVOUS NAV • (V83) RENDEZVOUS PARAMETER DISPLAY NO. 1 (R31) • (V85) RENDEZVOUS PARAMETER DISPLAY NO. 2 (R34) • (V90) RENDEZVOUS OUT OF PLANE DISPLAY (R36) • (V89) RENDEZVOUS FINAL ATTITUDE (R63) • (P76) TARGET DELTA V
ALIGNMENTS SECT 4.14	G&N ALIGNMENTS • (P51) IMU ORIENTATION DETERMINATION • (P52) IMU REALIGN • (P53) ALTERNATE LOS IMU ORIENTATIONS DETERMINATION • (P54) ALTERNATE LOS IMU REALIGN • (V40 N20) ZERO ICDU EXTENDED VERB • (V41 N20) COARSE ALIGN ICDU EXTENDED VERB • (V41 N91) COARSE ALIGN OCDU EXTENDED VERB • INFLIGHT COAS CALIBRATION SCS ALIGNMENTS • ALTERNATE SC INERTIAL ATTITUDE DETERMINATION AND GDC ALIGNMENT • INPLANE GDC ALIGNMENT • BACKUP GDC ALIGNMENT WITH COAS BACKUP GDC AND/OR IMU ALIGNMENT
EXPERIMENTS SECT 4.19	(1) S160–GAMMA RAY SPECTROMETER (1) S161–X-RAY FLUORESCENCE (1) S162–ALPHA-PARTICLE SPECTROMETER (1) S163–OPTICAL BAR PANARAMIC CAMERA (2) S164–S-BAND TRANSPONDER (1) S165–MASS SPECTROMETER (SMOG) (2) S166–3-IN. MAPPING CAMERA (3) S167–SOUNDING RADAR (3) S168–EM SOUNDER "A" (3) S169–FAR ULTRA-VIOLET SPECTROMETER (3) S170–BISTATIC RADAR (3) S171–IR SCANNING RADIOMETER (3) S173–SUBSATELLITE-PARTICLE MEAS (3) S174–SUBSATELLITE-MAGNETOMETER (2) S175–LASER ALTIMETER (1) CSM 112-114 (2) CSM 112-115A (3) CSM 115-115A
SYSTEMS MANAGEMENT SECT 4.5	PROPULSION • SPS • RCS EPS ECS C&WS TELECOM MECH SYS FLOODLIGHT OPERATING MODES GEN DATA

C-4H-104

Figure C-4. Support Procedures and Data